Aviation Week

Including Space Technology

25 Cents

A McGraw-Hill Publication

July 6, 1959

Pilot Report On USAF Integrated Instrument Panel

Aeroflot Il-18

Special Report on Aeroflot's Jets

NEW SOLID HI-TORQUE DRIVER DEVELOPS FULL POTENTIAL OF FAMED *HI-TORQUE RECESS!

Many months of intensive development research by Voi-Shan's Product Engineering Group produced the Hi-Torque solid driver design. The objective in mind was the development of an economical precision tool with minimum deflection and of optimum geometry which would fully exploit the tremendous torque capability and long service life of the Hi-Torque recess without affecting the superior static and fatigue strength which have made Hi-Torque the recess preferred by the world's largest aircraft manufacturing companies.

New Hi-Torque solid drivers are made from top grade die steel of very high strength, give minimum deflection and are virtually indestructible in service.

The driver tip geometry is ingeniously designed to load recess progressively in shear as torque load is applied. In ultimate torque condition the entire bearing area of the recess is evenly loaded (p.s.i.) in shear, values to failure being directly proportional to the material strength of the fastener, two typical values shown below.

Hi-Torque solid drivers require no axial load to maintain bearing and do not cam-out. Unique Hi-Torque "lock-in" action takes over and increases progressively as torque is applied. Ultimate failure of recess by shear-out is only reached after more than 2½ times recommended H.I.A.D. installation loads, as illustrated below.

Reserve power potential of new solid Hi-Torque driver-recess combination gives unlimited service life—essential in present-day aircraft structure where repeated installation and removal of fasteners is mandatory for field service and maintenance purposes.

The Hi-Torque wrenching system will solve your fastening problems. Full details on fasteners and drivers from:

PART NUMBER	BOLT SIZE	TENSILE STRENGTH P.S.I.	ULTIMATE TORQUE INCH-POUNDS	HI-TORQUE SOLID DRIVER NUMBER
NAS 584	¼"	160,000	265	HTS-4
HT 407	¼"	220,000	320	HTS-4

**Hi-Torque trademark registered U.S. Patent Office. Nos. 2,677,985; 2,745,120; 2,808,087. Other U.S. and Foreign Patents Pending.*

VSI

VOI-SHAN MANUFACTURING COMPANY

A DIVISION OF VOI-SHAN INDUSTRIES, INC.

8463 Higuera Street, Culver City, California

HERE'S SKID PROTECTION

sure and simple

Basic units of the Goodyear Anti-Skid System specified for the Convair B-58 and Republic F-105. Installed on a 2-wheel fighter, the system weighs under 6 lbs.

1 FIRST, CONSIDER THIS – At today's high landing speeds, a skidding tire can "flat spot" in two seconds. Several seconds later, it will blow out—endangering plane and personnel, requiring costly down time that can wreck flight schedules. The pilot—sitting ahead of wheels—can be unaware of danger until too late.

2 TO ANSWER THE PROBLEM—Goodyear offers *three* compact skid control systems: *Skid Warning System** instantly raps the pilot's brake-pedal foot when skid is imminent. He allows for skid, keeps control.

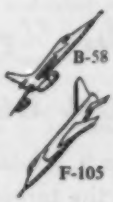
Anti-Skid System automatically releases brake pressure until skid danger has passed. Brake is reapplied automatically.

Pilot Modulated Anti-Skid System is combination of other two. Provides automatic skid protection yet allows pilot control if desired.

3 PROOF OF EFFECTIVENESS? *Goodyear Anti-Skid System*—specified for both the Convair B-58 and Republic F-105.

Goodyear Skid Warning System—exhaustively tested and enthusiastically received by military and commercial pilots. FAA-approved for Douglas DC-7B and DC-7C Aircraft.

Goodyear Pilot Modulated System—now proving itself on one of the newest military jets.

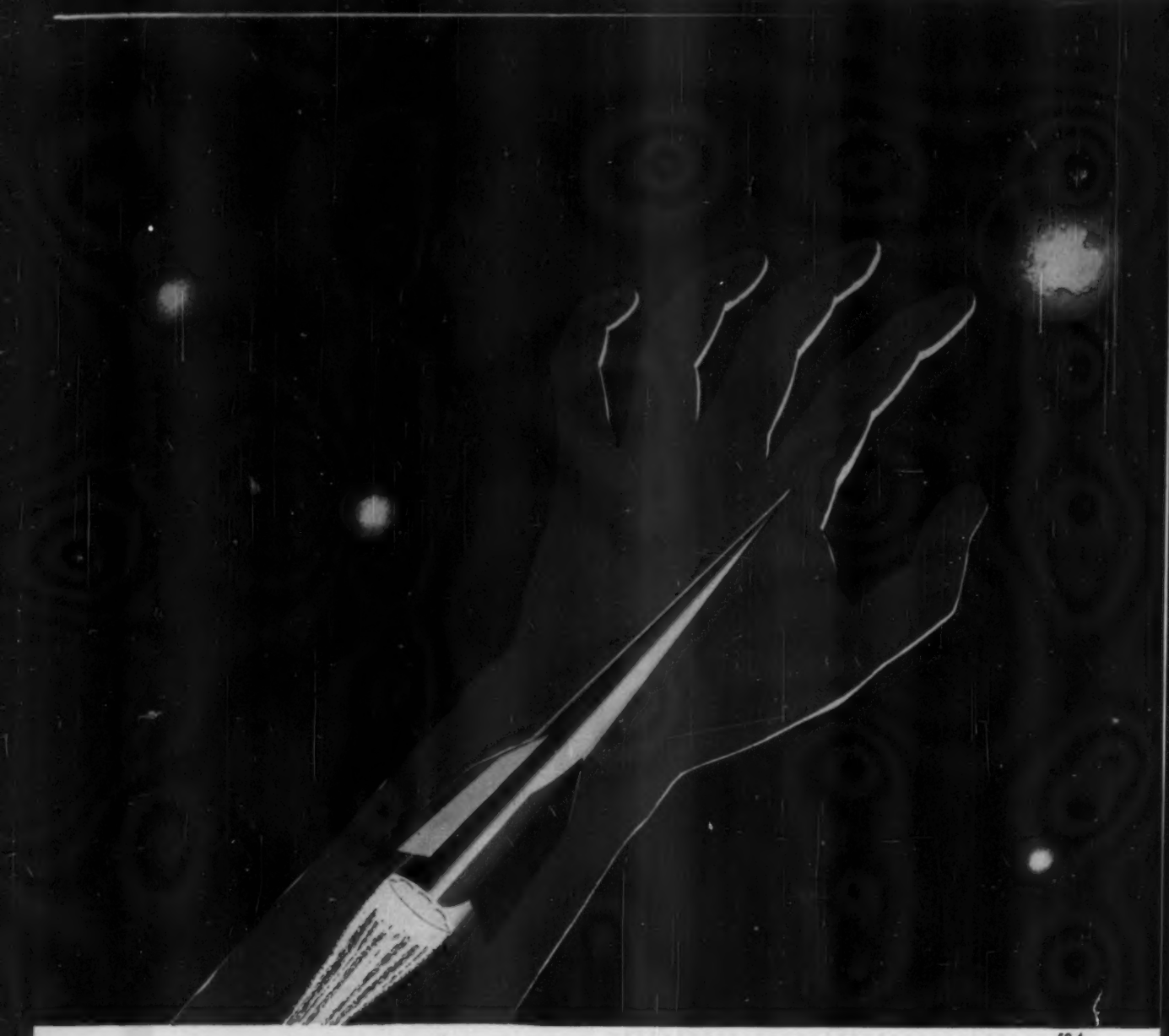


4 FOR DETAILED INFORMATION on these 3 miniaturized, lightweight skid control systems – and specific facts that will help you decide which system is best for you—write Goodyear, Aviation Products Division, Akron 16, Ohio, or Los Angeles 54, California.

AVIATION PRODUCTS BY

GOODYEAR

*Patents pending



59-4

the farther the "reach" the more critical precision becomes

Today's missiles demand tight accuracy because a ten-thousandth of an inch functional error can cause failure to reach the target a continent away. And when you're reaching toward a target almost a quarter of a million miles away, precision becomes even *more* critical!

Ex-Cell-O is in the accuracy business, meeting today's unprecedented demand for precision by building into every part, every assembly, every machine tool an exactness that the aircraft industry has counted on for higher, safer, faster flying for 40 years.

XLO

EX-CELL-O FOR PRECISION

MAN AND MISSILES FLY HIGHER, FASTER AND SAFER WITH PARTS AND ASSEMBLIES BY EX-CELL-O AND ITS SUBSIDIARIES: BRYANT CHUCKING GRINDER CO., CADILLAC GAGE CO., MICHIGAN TOOL CO., SMITH BEARING CO.

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

Aircraft Division

AVIATION CALENDAR

July 13-15—Tenth Anniversary Meeting, Airlines Electronic Engineering Committee, Aeronautical Radio, Inc., Ambassador Hotel, Los Angeles, Calif.

July 16-17—Third biennial joint meeting, Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

July 18—Invitational Civilian Pilot Fly-In (briefing, luncheon and static display), Pacific Missile Range, Pt. Mugu, Calif.

July 20-21—Propellant Thermodynamics and Handling Conference, American Rocket Society's Propellants and Combustion Committee, Ohio Union, Ohio State University campus, Columbus, Ohio.

July 30-31—Sixth Annual Symposium on Computers and Data Processing, Denver Research Institute, Stanley Hotel, Estes Park, Colo.

Aug. 4-5—Second Annual Western Regional Meeting, American Astronautical Society, Ambassador Hotel, Los Angeles, Calif.

Aug. 5-7—William Frederick Durand Centennial Conference on the problems of hypersonic and space flight, Stanford University, Stanford, Calif.

Aug. 9-12—Third National Heat Transfer Conference & Exhibit, University of Connecticut, Storrs, Conn. Sponsors: American Society of Mechanical Engineers; American Institute of Chemical Engineers.

Aug. 11-13—Wright Air Development Center Symposium on Aircraft Structural Fatigue Problems, Dayton Biltmore Hotel, Dayton, Ohio. (Confidential clearance required; must be filed with the Symposium Arrangements Committee, WCO, WADC, Wright-Patterson AFB, Ohio.)

Aug. 12-14—Eighth Annual Conference on Applications of X-Ray Analysis, Stanley Hotel, Estes Park, Colo. Sponsor: Metallurgy Division, Denver Research Institute.

(Continued on page 6)

AVIATION WEEK Including Space Technology

July 6, 1959
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The smallest, lightest,
PRECISION TRIMMING POT
on the market!

FAIRCHILD TYPE 926—3/8" DIAMETER TRIMMER

Smallest?...You can't get one any smaller, not when diameter and length measure only ⅜ of an inch.

Lightest? . . . Although it weighs only 3 grams, this precision micro-miniature trimmer incorporates a machined aluminum case, stainless steel shaft and precious metal wiper and contacts designed for high reliability. It is protected against dust and moisture by an "O" ring shaft seal.

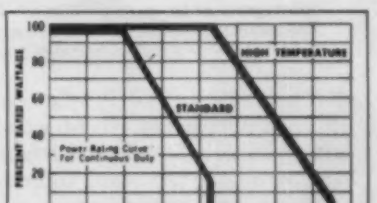
All this and reliability too . . . The Trimtite, Jr. meets MIL SPEC 202A for missile and aircraft applications, assuring constant setting over a wide range of severe environmental conditions.

Standard and high-temperature units are available in resistance ranges as high as 25K with linearity values as low as 3%. Power ratings at various ambients are shown below.

A "GIANT-SIZE" VERSION The Fairchild Trim-tite type 927—measuring ½ inch in diameter and length, and weighing 9 grams—is available in resistance ranges as high as 50K. Resistance values up to 150K can be supplied on special order.

Standard units in a wide range of resistance values are available for off-the-shelf delivery.

For complete specifications and detailed application information regarding your particular requirements, write to Dept. 32Y



RELIABILITY INSIDE THE BLACK BOX

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COMPONENTS DIVISION
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A Subsidiary of Fairchild Camera and Instrument Corporation

GYROS
PRESSURE TRANSDUCERS
POTENTIOMETERS
ACCELEROMETERS

UNIQUE GAUGE MOUNTING ON F8U-1 CRUSADER — Three RMC-Lindsay high pressure gauges are flush-mounted in the outside skin of this F8U-1, for quick, accurate ground checking of pneumatic systems.

Skin-mounted RMC-Lindsay pressure gauges give Crusader quick, accurate ground check...

The Chance Vought Crusader's pneumatic systems are ground checked with a glance at the RMC-Lindsay High Pressure Gauges installed in the outside skin of the plane.

3,000 supersonic miles—and a transcontinental record later, they will still be registering accurately . . . as they will for the life of the plane.

Two of the gauges are of the suppressed zero type, registering from 1,000 to 4,000 p.s.i. The other registers from 0 to 4,000 p.s.i.

These gauges have undergone a 50G shock test with no ill effects. They will withstand vibration from 10 cps. to 2,000 cps. at 25Gs, at ambient temperatures from −65°F to +350°F. They are moisture sealed at the crystal.

There is no linkage, no gear train to disintegrate or to cause pointer vibration. The indicating pointer is attached directly to the end of the helical bourdon tube.

MODEL #6903 (Actual Size)

RMC-Lindsay High Pressure Gauges have proved themselves—in performance—on record-setting transcontinental jet flights, on innumerable take-offs and landings, on missile guidance systems, and on missile test stand countdowns.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write, wire or phone either of the addresses below.

ROCHESTER MFG. CO. OF CALIFORNIA
1401-A S. Shamrock Ave., Monrovia, Calif.
ROCHESTER MANUFACTURING CO., INC.
221 Rockwood Street, Rochester 10, N. Y.

RMC
LINDSAY PRESSURE GAUGES

AVIATION CALENDAR

(Continued from page 5)

Aug. 17—First National Ultrasonics Symposium, Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, Stanford University, Stanford, Calif.

Aug. 18-21—Western Electronic Show & Convention, Institute of Radio Engineers, Cow Palace, San Francisco, Calif.

Aug. 24-26—Gas Dynamics Symposium, American Rocket Society, Northwestern University, Evanston, Ill.

Aug. 24-26—Institute of the Aeronautical Sciences' National Specialists Meeting, a symposium on anti-submarine warfare, (classified), San Diego, Calif.

Aug. 27-28—International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England.

Aug. 31-Sept. 2—Annual Army-Navy Instrumentation Program (ANIP) Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex.

Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 1-2—Conference on physical chemistry in aerodynamic and space flight, University of Pennsylvania, Philadelphia, Pa. Sponsors: Air Force Office of Scientific Research and General Electric Co.'s Missile and Space Vehicle Dept.

Sept. 2-4—1959 Cryogenic Engineering Conference, University of California, Berkeley, Calif.

Sept. 3-6—National Convention and Aerospace Panorama, Air Force Assn., Exhibition Hall, Miami Beach, Fla.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 9-11—Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Tex. Sponsors: AFOSR/Directorate of Aeronautical Sciences; Office of Naval Research; National Science Foundation.

Sept. 16-17—Western Regional Meeting on Frontiers on Science and Engineering, Institute of the Aeronautical Sciences, Los Angeles, Calif.

Sept. 20-25—14th Annual Conference and Exhibit, Instrument Society of America, Chicago Amphitheater, Chicago, Ill.

Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.

Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 24-25—Solid Propellants Conference, American Rocket Society, Princeton University, Princeton, N. J.

Sept. 28-30—1959 National Symposium on Telemetering, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers' Professional Group on Space Electronics & Telemetry.

Oct. 5-7—Seventh Anglo-American Aeronautical Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York.

Oct. 5-10—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.

Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.

GPL combined guidance

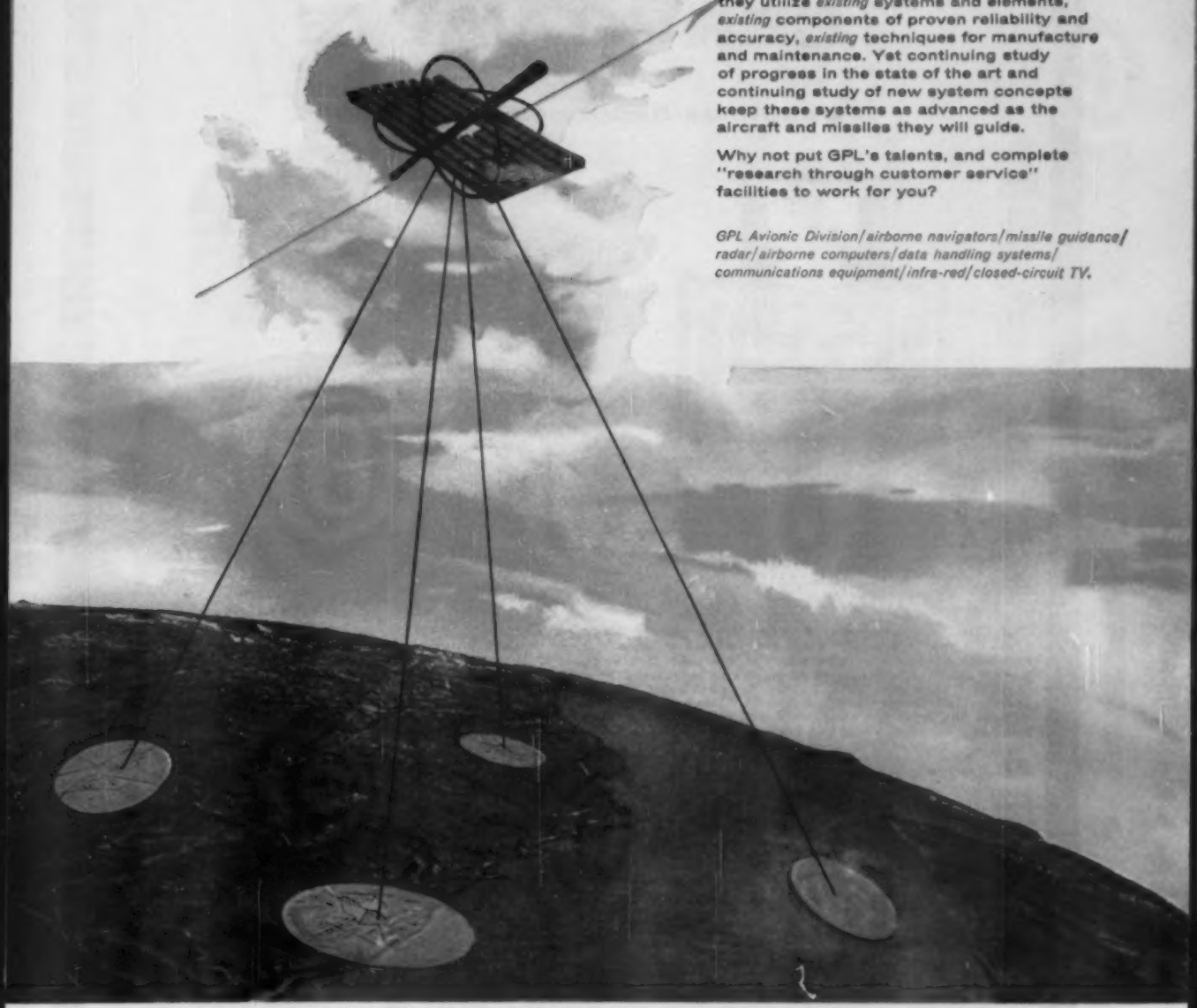
A.I.D. Navigation Systems

Combining state-of-the-art equipment in several fields to create new and superior systems for aircraft and missile guidance is still another GPL capability. One case in point is GPL's Astro-Inertial-Doppler A.I.D. navigation system—a stellar monitored, doppler tuned and damped inertial system—in which each element refines the others, and the system as a whole provides far greater inherent accuracies.

A.I.D. and other combined guidance and integrated systems now under development at GPL are particularly significant because they utilize *existing* systems and elements, *existing* components of proven reliability and accuracy, *existing* techniques for manufacture and maintenance. Yet continuing study of progress in the state of the art and continuing study of new system concepts keep these systems as advanced as the aircraft and missiles they will guide.

Why not put GPL's talents, and complete "research through customer service" facilities to work for you?

GPL Avionic Division/airborne navigators/missile guidance/radar/airborne computers/data handling systems/communications equipment/infra-red/closed-circuit TV.



ENGINEERS — GPL achievements have opened up some unusual research and development opportunities. Send resumé to Personnel Director.

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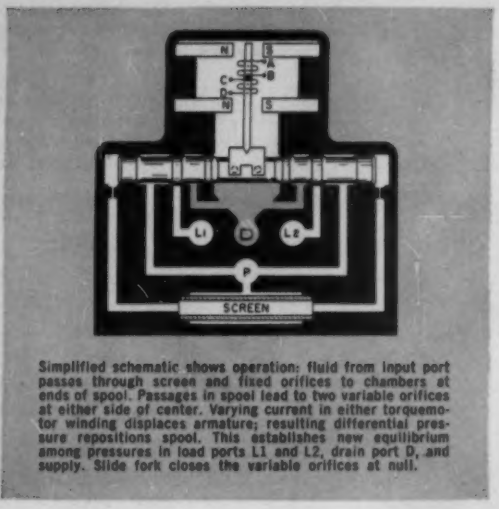
Hydraulics . . . another Kearfott capability

KEARFOTT ELECTROHYDRAULIC SERVO VALVE

obsoletes flapper-nozzle designs



Simplified schematic shows operation: fluid from input port passes through screen and fixed orifices to chambers at ends of spool. Passages in spool lead to two variable orifices at either side of center. Varying current in either torquemotor winding displaces armature; resulting differential pressure repositions spool. This establishes new equilibrium among pressures in load ports L1 and L2, drain port D, and supply. Slide fork closes the variable orifices at null.

Actual Size

Kearfott's unique approach to the design of electrohydraulic feedback amplification has resulted in reliable, high-performance miniature servo valves with just two moving parts. Ideally suited to missile, aircraft and industrial applications, these 2-stage, 4-way selector valves provide high frequency response and extreme reliability without the need for mechanical null adjustments. This reliability has been tested and proved not only by Kearfott but by a number of firms prominent in the missile field.

Anti-Clogging Design

Large orifices prevent clogging and silting and high shear forces permit efficient operation even with highly contaminated fluids. Positional feedback substantially reduces flow force reactions while hydraulic centering of pilot position eliminates the effects of hysteresis and null shift. Even under extreme temperature variations, Kearfott's unique valves consistently function at optimum efficiency.

Kearfott servo valves provide full motor power since the high ratio of available force to friction makes possible a lower threshold, reducing dead band and minimizing force required for centering motor. They are available in a variety of types, including #6103 with a flow rate of .3 to 4 gpm and #6104 with a flow rate of .8 to 10 gpm.

Typical Characteristics

Quiescent Flow.....0.15 gpm	Supply pressure....500 to 3000 psi
Hysteresis.....3% of rated current	Temperature-Fluid & Ambient.....−65°F to +275°F
Deadband.....1% of rated current	Flow Rate Range.....3 to 10 gpm
(Minimumcurrenttoestablishflow)	Weight.....10.5 ounces

DESIGNS AVAILABLE WITH FREQUENCY RESPONSE OUT TO 250 CPS

Hydraulic actuator subsystems can be supplied as follows:

- Linear or rotary actuators with or without positional feedback and power supply.
- Servo valve-actuators. Feedback can be provided consisting of voltage or resistance devices.
- Actuators whose bodies contain first and second stages of the servo valve with torque motor mounted on common actuator-valve body. Feedback devices can be supplied integral with actuator or mounted externally.

Write for complete information on Kearfott valves today.

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
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Sales and Engineering Offices: 1500 Main Avenue, Clifton, N. J.
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Engineers: Kearfott offers challenging opportunities in advanced component and system development.

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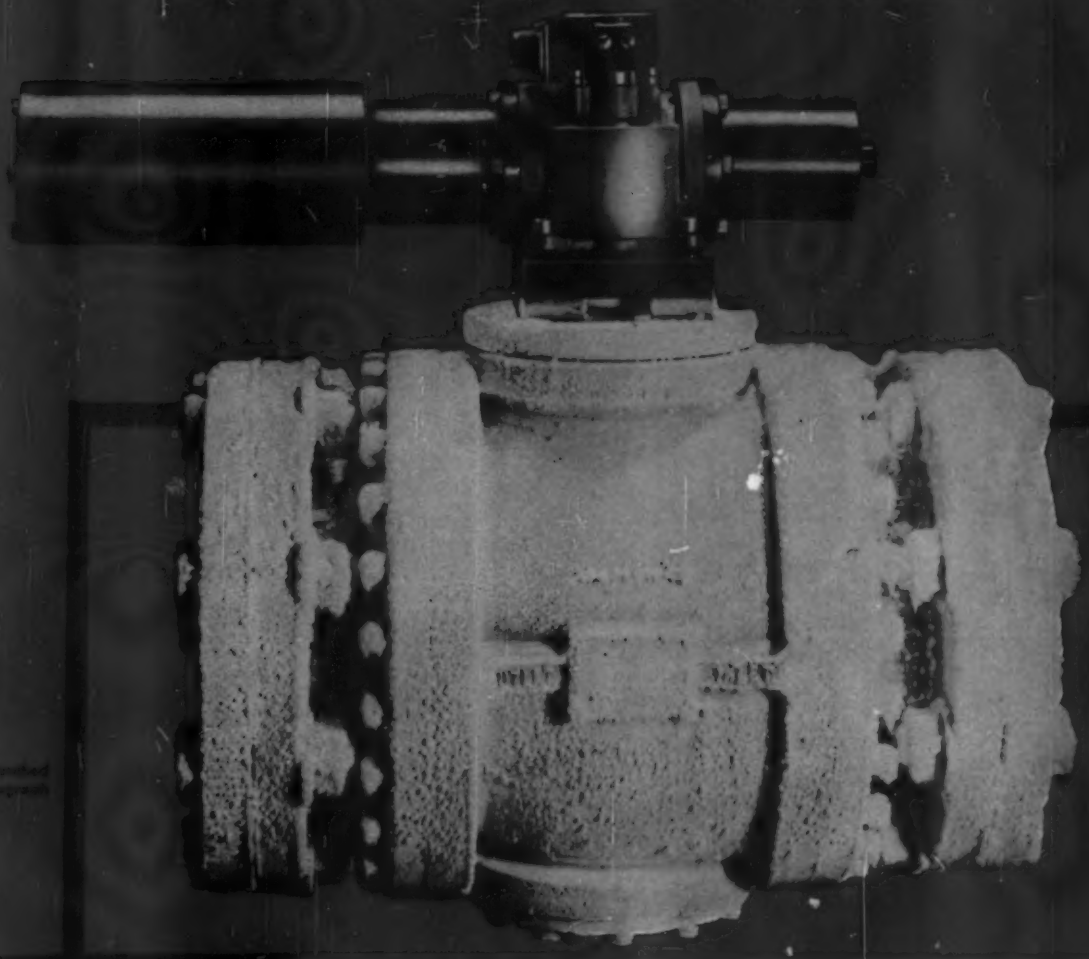
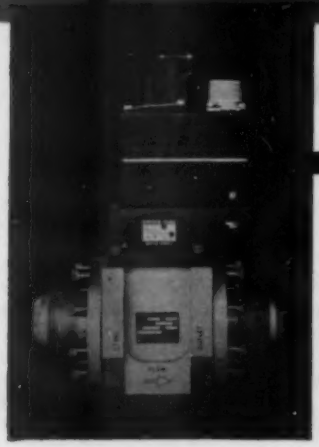
Maximum performance





... at -320°F.

Hydromatics *FLO·BALL* valves

Hydromatics makes them all---from fast-acting motor-operated airborne valves that control 3250 psi helium at −360°F., to compact 6″ LOX fueling valves that can fill a missile from mobile transfer equipment in just 2 minutes.

All incorporate Hydromatics unique 100% flow efficiency characteristic.

For off-the-shelf hardware to meet your temperature requirements down to −425°F., write for complete information on Hydromatics outstanding line of ***FLO·BALL*** valves for high pressure, cryogenic and corrosive applications.

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FLO·BALL

YOU ASKED FOR IT . . .
FOR MISSILE AND AIRCRAFT SYSTEMS . . .

VARIABLE DISPLACEMENT PUMP DATA

MODEL	DISPL. IN 3/REV.	RATED RPM	RATED GPM	MAX. RPM	ENVELOPE DIM. DIA.	ENVELOPE DIM. LENGTH
P175	1.750	4000	29.4	5000	5.750	8.320
P105	1.050	4000	17.3	6000	5.250	7.250
P56	.568	6000	13.9	8000	4.687	6.625
P16	.163	12000	7.9	16000	3.000	4.250
P11	.115	12000	5.5	16000	2.750	3.625
P064	.064	12000	3.1	18000	2.125	3.125
P044	.044	12000	2.1	18000	2.125	3.062

A NEW FAMILY OF BENDIX
CONSTANT AND VARIABLE DISPLACEMENT HYDRAULIC PUMPS

SMALLER • LIGHTER • FEWER PARTS • SYMMETRICAL ENVELOPE • COMPACT • RUGGED DESIGN

INHERENT HIGH SPEED CAPABILITIES • SUPERIOR CONTAMINATION TOLERANCE • HIGH RELIABILITY

The rugged, simplified construction of Bendix® hydraulic pumps plus precision production and quality control experience provide pumps with increased reliability for missile and aircraft systems. Smaller envelopes permit interchangeability with existing installations and compact packaging for new applications. Thousands of hours of endurance, qualification and flight testing have proven the Bendix family of hydraulic pumps will exceed all existing customer and military requirements.

Pumps are furnished as separate components or as an integral part of complete sub-systems. Standard pumps are furnished with forged aluminum housings for temperatures up to 400°F. and pressures up to 4,000 psi. Previous qualification of pumps for 550°F. assures you of high reliability for lower temperatures and availability of proven pumps for high temperature systems.

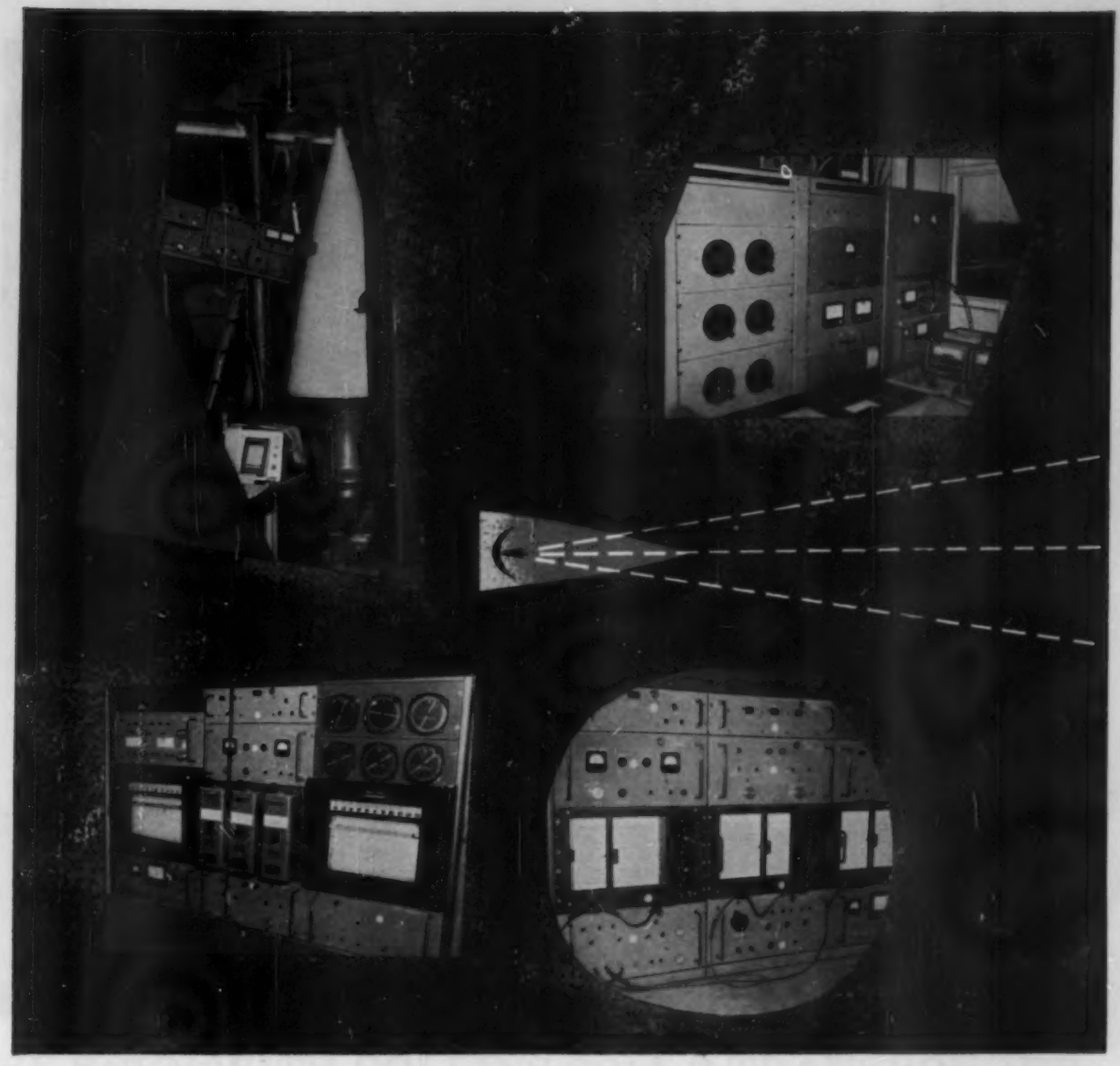
Advanced engineering, laboratory, precision manufacturing and complete service facilities are available for producing and servicing Bendix hydraulic pumps. This assures you of a quality pump manufactured specifically for your application.

All pumps are assembled and tested in a new air-conditioned, humidity-controlled, dust-free area assuring contaminate-free pumps as delivered.

MAJOR PRODUCTS—aircraft and missile hydraulic pumps; hydraulic components and sub-systems; engine fuel pumps and fuel system components; precision bellows and bellows assemblies; thermostats and related sub-assemblies; and sub-contract manufacturing and brazing.

Hamilton Division
HAMILTON, OHIO

Bendix
AVIATION CORPORATION



BORESIGHT ACCURACY TO 1/15 MILLIRADIAN? SEE BRUNSWICK

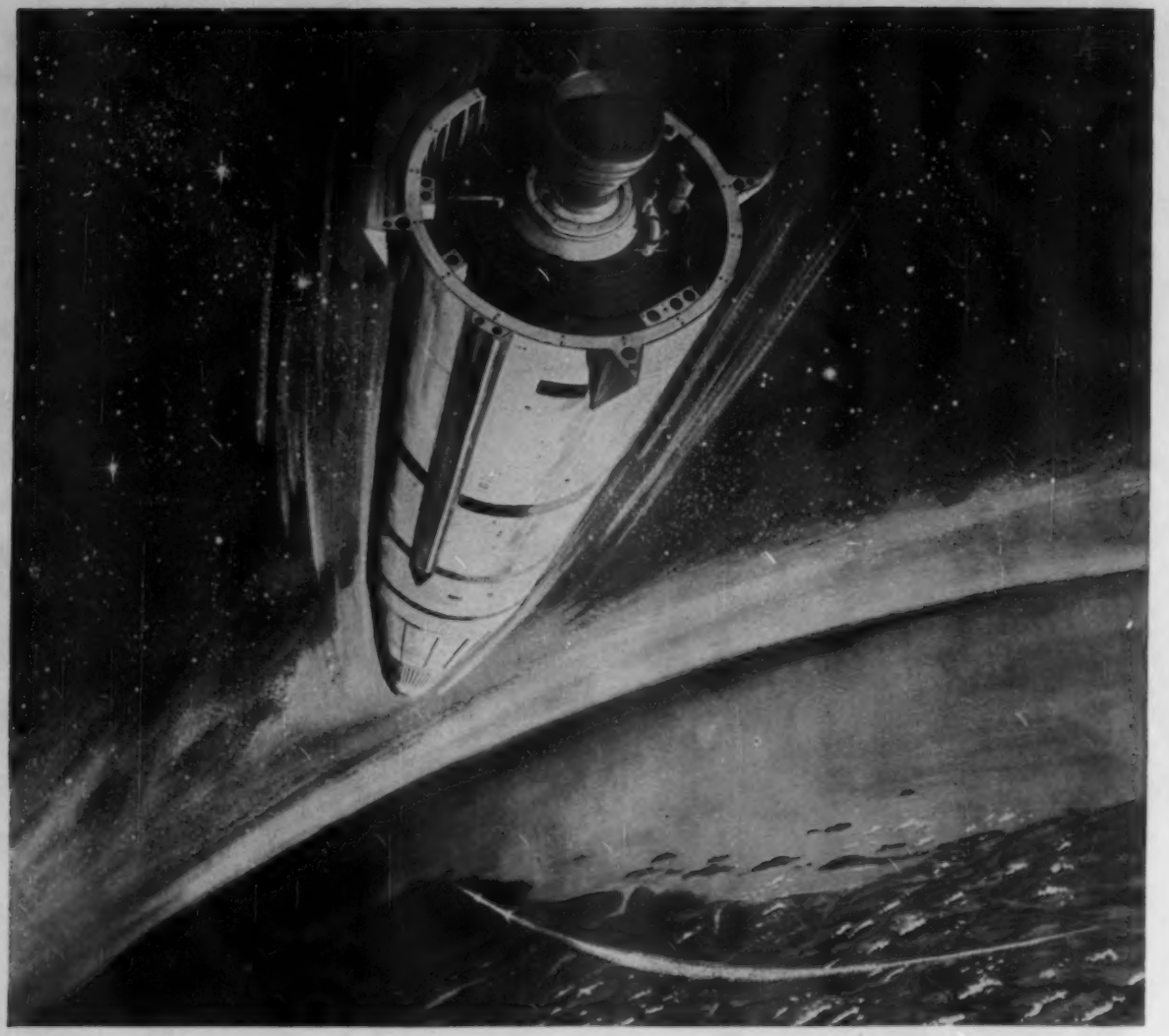
Brunswick-built radomes are setting new highs not only for strength-to-weight ratios, but accuracy as well. The reasons for the accuracy are simple: Brunswick has the test facilities and know-how that are without peer in the industry. Three radome ranges which automatically detect boresight error to an accuracy of 1/12 to 1/18 milliradian are now in full operation at Brunswick.

Soon to be in operation: two 1,000-foot ranges, manually operated, that will assure even more refined accuracy, detecting errors as small as 5 seconds of arc. Also, as an aid to design, quality control and maintenance of electrical tolerances, Brunswick is currently utilizing a one-horn interferometer for accurate IPD measurements and corrections before final range testing.

Behind these extensive test facilities operates an engineering team skilled in both detecting and *correcting* boresight error. To learn how this combination of facilities and engineers can give you uniquely accurate, tough and lightweight radomes, write to: Brunswick-Balke-Collender Company, Defense Products Division Sales Manager, 1700 Messler St., Muskegon, Michigan.

BRUNSWICK

MAKES YOUR IDEAS *WORK*



INTERCEPT!

Solar's creative missile team helps solve one of America's most vital defense problems

MISSILE DEFENSE involves the interception and destruction of a relatively small target travelling through space at over twenty thousand feet per second... within minutes after it is launched.

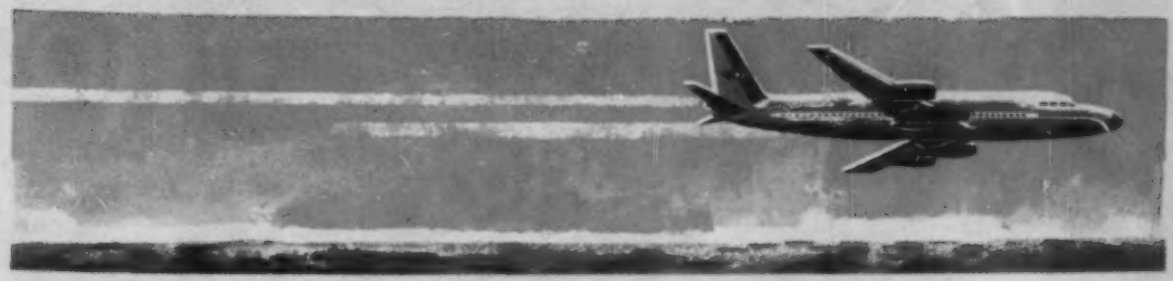
The government's Advanced Research Projects Agency has assigned Solar the task of working out a solution to an important part of this pressing military problem. This important new study contract, awarded as a result of a unique new approach to missile defense devised by Solar's creative weapon systems team, will require the very best engineering imagination and know-how. It will result in an important forward step in missile science.

With years of active experience in the many phases of missile and space technology, Solar is particularly qualified to help solve *your* design, development and production problems. For detailed information about Solar's proven problem-solving skills, write to Dept. G-129, Solar Aircraft Company, San Diego 12, California.

ENGINEERS WANTED! Challenging projects, unlimited opportunities with Solar. Write today!

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

BE SEEN EN ROUTE



BE SEEN ON APPROACH

BE SEEN IN EXCELLENT AIRLINE COMPANY

BE SEEN WITH COLLINS 621A-2 TRANSPONDER

For airline or business aircraft, Collins 621A-2 ATC Radar Transponder provides a strong radar reply and rapid identification for precision ETA's and no-delay clearances in high density control areas.

Designed to the highest standards of performance, reliability and maintainability, the Collins 621A-2 features unique high stability decoding and encoding circuits, fully shielded transmitter to minimize radiated interference, and superior cooling design. Expansion capabilities for future requirements are incorporated.

Proven by extensive airline evaluation, and backed by the world's most experienced supplier of airline communication and navigation equipment, the 621A-2 is today's best buy in ATC Transponders.

COLLINS

COLLINS RADIO COMPANY • CEDAR RAPIDS, IOWA • DALLAS, TEXAS • BURBANK, CALIFORNIA

SIKORSKY HSS-2

U. S. Navy's new hunter-killer turbocopter

The Navy's new turbine-powered HSS-2 helicopter, developed by Sikorsky Aircraft, is this country's newest anti-submarine weapons system, the first helicopter that can both search out and destroy enemy undersea craft.

This versatile helicopter, with modifications, is also ideally suited for troop, cargo, and rescue operations of other U.S. military services.

The HSS-2 features a boat hull and can operate from land, shipboard, water, ice, snow, mud or tundra. Twin turbine engines, each rated at 1050 shp, give it superior range, speed and payload.

Improved submarine detection equipment and an advanced navigation system developed jointly by the Navy and Sikorsky, combined with anti-icing equipment for the rotor assembly and automatic stabilization equipment, make the HSS-2 an integrated weapon system capable of around-the-clock all-weather operation.

Now in production, the HSS-2 is Sikorsky's second boat-hulled turbocopter. It joins a family of Sikorsky helicopters whose service is unequaled in military and commercial operations throughout the world. SIKORSKY AIRCRAFT, Stratford, Connecticut. A division of United Aircraft Corporation.

COUNT DOWN

for the conquest of space

"MISSION ACCOMPLISHED: DEPARTING LUNA 2205 ZEBRA"

This message, flashed across a quarter-million miles to Washington, D.C., will be awaited anxiously by millions.

But even then our first expedition to the moon will still face its most crucial test—the journey home to earth.

The success of that trip will depend in large part on rocket propellants—fuels and oxidizers that will have been stored for days in the tanks of the expeditionary vehicle and yet will respond instantly when needed.

Storable liquid propellants is one of the fields in which Rocketdyne has anticipated the future. For more than ten years, its propellant chemists have been studying, engineering, and testing combinations of storable fuels and oxidizers for greater storability and higher energy.

Storability PLUS high energy

Rocketdyne has tested these combinations in all production and experimental engines. The results prove that today's storable fuels and oxidizers have these important capabilities:

(1) High performance, even after months or years of storage; (2) Stability over a wide temperature range, permitting storage in missile tanks without rigid environmental controls; (3) Dependable performance, predictable even at extremes of heat and cold; (4) Instant readiness for firing at any time during the storage period; (5) Energy yields equal to or higher than those of conventional propellant combinations.

Second-generation missiles

The tests also prove that engines developed for conventional propellants can be converted to storable combinations rapidly and inexpensively—a significant consideration in the development of second and third generation strategic, tactical, and air defense missiles.

Significant, too, is the *potential* performance of storable combinations. Research points to energy yields as high as 400 seconds of altitude specific impulse—performance 20 percent higher than that of today's combinations. These high-energy yields will offer new capabilities and greater flexibility for America's scientific and military programs.

Stepping stones to Space

Rocketdyne has designed and built much of today's operating hardware in the high-thrust rocket field. Engines by Rocketdyne power most of the military and scientific projects sponsored by Air Force, Army, and NASA. This experience now becomes the point-of-departure for tomorrow's journeys into the unknown.

POWER FOR AMERICA'S MISSILES

Thrust chamber production line for Thor and Jupiter at Rocketdyne's Neosho, Mo., facility moves smoothly.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

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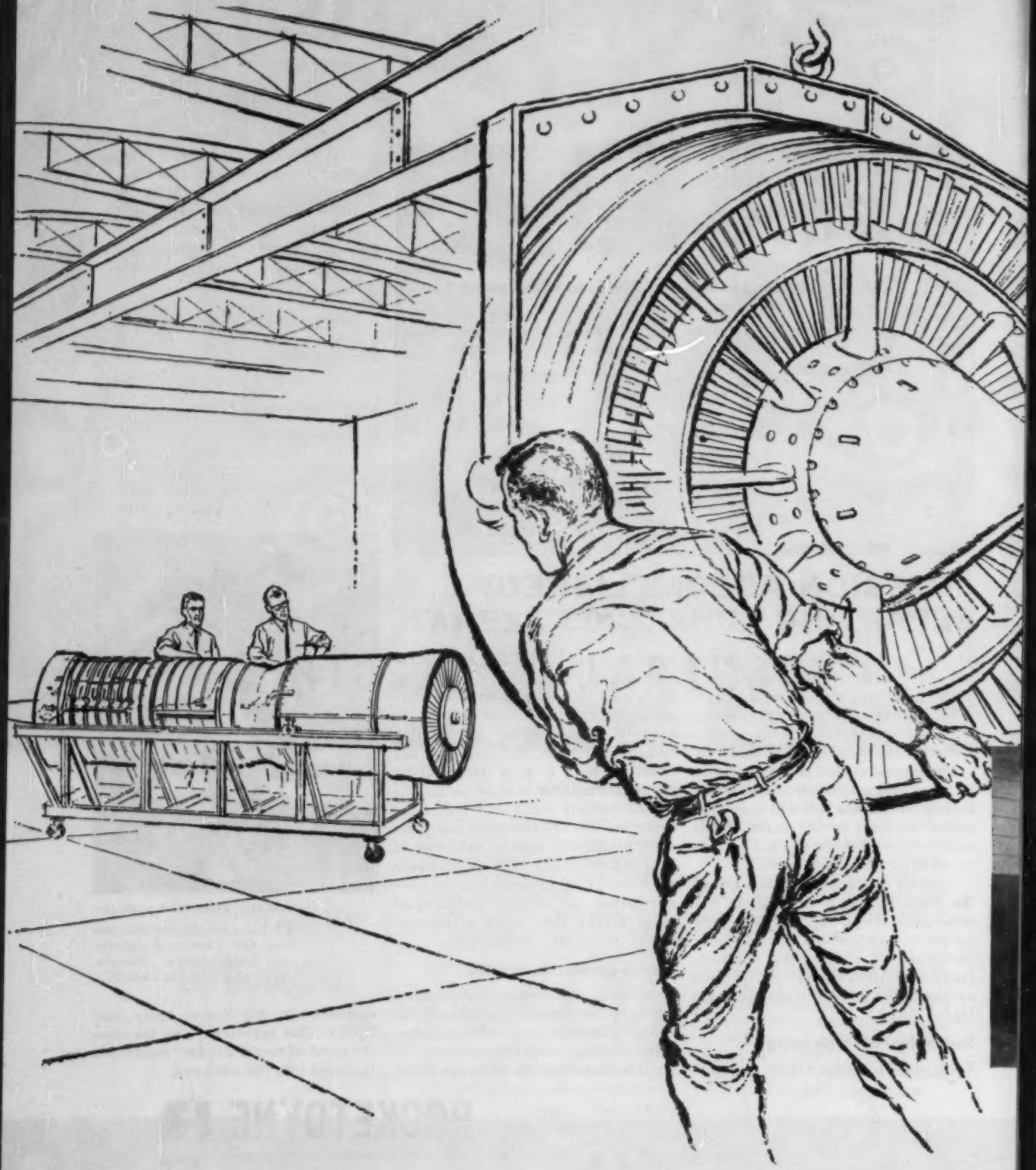
General Electric's AFT fan unit provides



DESIGN SIMPLICITY

By placing the fan unit *aft*, General Electric engineers produced a simple design for advanced turbofan engines. General Electric's turbofan is built around the same highly reliable, single rotor, variable-stator compressor gas generator design which has already been proven in thousands of hours of operational flying by the J79.

Aft of this basic gas generator, a single-stage turbine/fan combination is added. Addition of the fan assembly, which requires only two bearings, leaves the gas generator hardware unchanged and its operating characteristics unaffected.

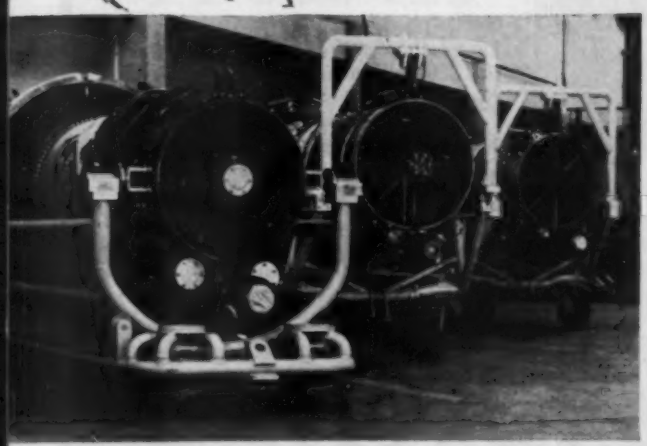
Aft placement of the fan offers these important operating advantages:

- Lower fan blade tip speeds, with thoroughly proven low aspect ratio transonic blading
- Simplified thrust reversal—one reverser handles both fan and engine exhaust
- High resistance to foreign object damage—rugged single-stage fan blading has high impact strength, and its *aft* placement eliminates the possibility of fan damage causing main engine damage
- Intricate anti-icing system unnecessary—fan structure is warmed by exhaust gases
- Growth flexibility—fan and gas generator performance can be advanced independently

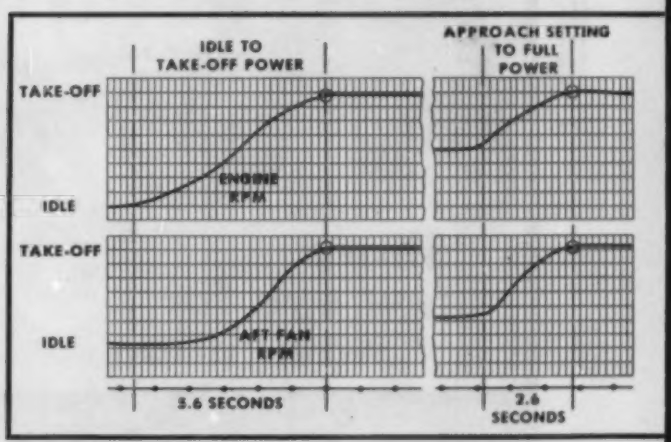
Turbofans offer greater fuel economy, bigger payload and longer range. The *aft* fan provides these advantages without compromising gas generator operating characteristics, and placing the fan *aft* yields the simplest possible mechanical design. For more information, write to Section 235-36, General Electric Co., Cincinnati 15, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC



General Electric presents a line of simple, reliable turbofan engines that will deliver excellent, economical performance with low maintenance costs.



Tracing shows quick, stall-free throttle response of engine and fan during operation of a G-E aft fan engine. Aerodynamic coupling gives instant, positive, continuous control of fan speed, without mechanical connection between engine and fan rotors.

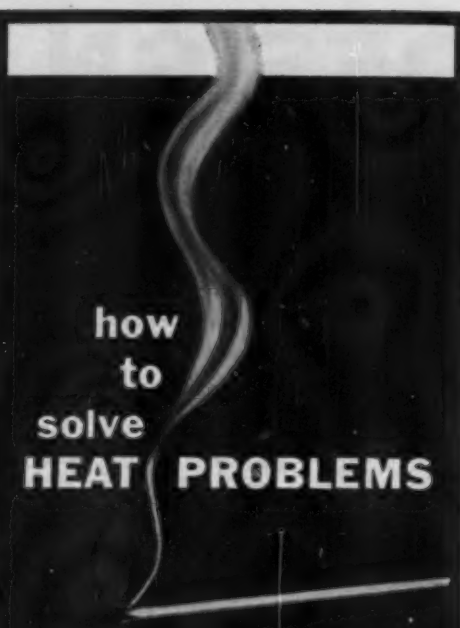
FIREBEE···THE HIT OF PROJECT WILLIAM TELL

"I'll never want to fire at towed targets again!"

That's the typical reaction of Air Force interceptor pilots after they fired at Ryan Firebee jet targets during the recent "Project William Tell" Weapons Meet.

78 Firebees, launched off the Florida coast, brought combat realism to the 10-day meet. Acting as "enemy" jet bombers, the free-flying Firebees streaked in at over 500 mph, from 14,000 to 42,000 feet, and flew an average of 31 minutes each.

Air Force pilots and weapons systems crews met this realistic test with the most impressive teamwork and skill ever displayed at a weapons meet.



how to solve HEAT PROBLEMS

Fastest way to solve space age heat problems of aircraft and missiles is to put Ryan to work for you.

Ryan has spent 20 years in applying advanced metallurgy to production techniques with 35 high-temperature alloys ...has fabricated them into critical hot parts for many major power plants... has put them into volume production.

Ryan hot parts are giving outstanding service in turbo-jets, afterburners, prop-jets, ramjets, rockets, and piston engines. That's why Ryan has the answers to high-temperature problems – from hot parts to complete engine packages.

Sharp new eye for navigation

Six major types of Navy aircraft will be equipped with Ryan continuous-wave Doppler navigation systems under an initial $20-million contract awarded by the Navy to Ryan's Electronics Division.

Developed in cooperation with the Navy, these advanced electronic systems are the lightest, simplest, most compact, most reliable of their type.

This new order, one of the largest of its kind, further emphasizes Ryan's leadership in electronic navigation and guidance systems.

Ryan offers outstanding challenges to engineers

RYAN BUILDS BETTER

AIRCRAFT · POWERPLANTS · ELECTRONICS

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July 6, 1959

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EDITORIAL

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COVER: Aeroflot Il-18 turboprop transport is shown on approach to landing at Alma-Ata, capital of the Kazakh Republic, with the snow topped Tien Shan mountains in the background. The 80-passenger Il-18 makes the 2,100 mi. Moscow-Alma-Ata nonstop run in five hours and flies a round trip daily. More than 40 Il-18s are now in service and training operations with Aeroflot on long range routes beyond the range of the Tu-104 turbojet series. CSA, the Czechoslovakian airline, has ordered Il-18s for use on its Prague-London route. For details in Aeroflot's operations, see p. 34.

PICTURE CREDITS

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Exercise: Banyan Tree

"Under the code name *Banyan Tree* the Strategic Army Corps (STRAC) and the Tactical Air Command (TAC) joined in a major Army-Air Force exercise that involved the rapid reinforcement of forces in the Caribbean which were presumed to be fighting an Aggressor force intent on seizing the Panama Canal.

"The key phase of the operation was the airlift of the reinforced 2nd Battle Group, 501st Infantry, of the 82nd, non-stop from Fort Bragg, North Carolina, to an airdrop in the maneuver combat zone at Rio Hata, Panama, 75 miles southwest of Panama City and the Canal Zone.

"The airlift took some seven and one-half hours in 21 C-130A (Hercules) prop-jet transports... Major General Hamilton H. Howze, Commanding General of the 82nd Airborne Division, making his fifteenth jump, led some 1,388 paratroopers out of the doors of the transports exactly on schedule, in a beautiful drop from about 1,250 feet. C-130s also brought in 105 mm. howitzers, ¾-ton trucks, and other heavy equipment...which was airdropped into the combat zone...

"The uniform excellence of the airdrop, both of personnel and equipment, proved how rapidly combat units can be assembled in battle areas ready to fight the enemy. The clocklike precision of the air-transported men and equipment indicates a continuing advance in our ability to reinforce and sustain combat elements when they have been committed."

Excerpts courtesy ARMY Magazine

Left: *"Parachutes coming down after a nonstop flight from the piney woods of North Carolina to the palm-fringed jungles of Panama"*

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EDITORIAL

Aeroflot's Jet Era

The 11-hr. nonstop flight of a Tu-114 turboprop airliner from Moscow's Vnukovo Airport to New York's International terminal at Idlewild was a significant punctuation point in the three year program of Aeroflot, the Soviet airline, to become a first class operator in the jet era. It is three years ago to the month that we reported in these pages on our first interview with Aeroflot officials in Moscow and detailed their plans for changing their airline from an early vintage Douglas DC-3 type operation, which it was in 1956, to a modern first-class jet-powered competitor in the international market.

The Aeroflot officials with whom we talked in 1956 (Maj. Gen. Eugen Beletsky, then operations chief, has since retired but Victor Danielichev is still the chief and spark plug of the foreign section) outlined in broad terms both the new family of gas turbine powered transports then in early development stages and their blueprint for international expansion of an airline that was then serving only Peking, Copenhagen and Helsinki outside the Soviet Union's border.

They told us then that New York was one of their terminal goals along with the other major capitals of Europe and Asia but that they would not press for U.S. terminals until they had the proper equipment to fly the route. And Andrei Tupolev left little doubt of his confidence, even then, that the Tu-114 turboprop transport would be the airplane for that job.

When we reported these plans (AW July 9, p. 26, 1956) they were greeted with considerable scepticism, particularly by people who had flown the Il-12 coffee-grinders and 15 passenger Li-2s (DC-3s built under license) from Aeroflot's grassy and muddy fields. Looking back on our own entry into the Soviet Union in June, 1956, we remember the 160 mph. Il-12s with propellers that defied synchronization, a 200 lb. stewardess whose only uniform apparently was a red sweater and the long rattling vibrating grind from Copenhagen to Riga to Vnukovo. Remembering this, it was hard to believe the 500 mph. service we flew last month in a Tu-104B twin jet from Tashkent to Tbilisi with nattily uniformed stewardesses, hot in-flight meals, a 96-passenger load and a smooth, relatively quiet and vibrationless ride that gobbled up one of the world's largest deserts, the Caspian Sea and a piece of the Caucasus Mountains in just three hours despite head winds. It was equally hard to reconcile the Il-18 service we sampled on the 2,100 mi. nonstop run from Moscow to Alma-Ata, almost the equivalent of transcontinental U.S., in five hours with two adequate in-flight meals, comfortable but not overly large reclining seats and a smooth cruise at 25,000 ft. altitude and a ground speed of 510 mph., with our 1956 experience.

The airline that had only six Tu-104, 50-passenger jet transports in mid-1956 and had to use Tu-16 (Badger bombers) to provide its crews with jet transition training today operates nearly 200 gas turbine transports with more rolling off the production lines every month.

In perspective, this three year leap into mass jet transport operations appears breathtaking. Actually it was a technically conservative process, backed by a top priority political mandate. The first Tu-104s, in their 50-passenger uneconomical version, went into Aeroflot service in the fall of 1956. In July of 1957 the prototype of the 70-passenger Tu-104A, the turboprop Il-18 and An-10 and the four jet 100-passenger Tu-110 appeared publicly and began flight testing. But it was not until August, 1958, that the Il-18 was deemed operationally sound enough to begin its final shakedown period on cargo and mail service.

Aeroflot follows an extremely conservative training and break-in policy on new equipment similar to that often advocated in this country but seldom practiced. The Il-18 flew on cargo proving runs over regular route segments until April, 1959, when it was put into passenger service and now is taking over new routes every month.

The An-10, which has had propeller lateral stability and engine problems, still is being shaken down on cargo and mail service, although the end of this period now appears in sight. Aeroflot expects to get into An-10A combined passenger-cargo service on the grass field network of the Ukraine this fall.

Even the 70-passenger Tu-104A did not reach the new economic standards that Aeroflot is suddenly heeding. An even higher density seating arrangement was forthcoming in the Tu-104B which went into regular service in May. The development of the 100-passenger twin jet Tu-104B eliminated any requirement for the Tu-110 four jet design aimed at the same capacity and the model has been definitely abandoned.

Meanwhile the Tu-114, which has been operationally tested for more than a year, is nearing the end of its shakedown period. Aeroflot's several thousand hours of experience with its quartet of Tu-114s now flying indicated sufficient confidence in the equipment to send it on a spectacular long-range international mission carrying a top political figure in addition to Designer Tupolev and his wife. Aeroflot is counting heavily on the Tu-114 to expand its international routes to North and South America and also to introduce a new standard of extremely low fare, high density "commuter" service on its high density, domestic routes.

As might be expected, this expansion into large scale jet operations has brought Aeroflot its share of problems and many of them are still unsolved or only partially fixed. The Soviet aircraft industry is definitely in the international export market with jet transports and helicopters. It was bitterly disappointed at its inability to sell the Tu-104 abroad because of its low seating capacity and uneconomical operating characteristics. It was a bitter pill when CSA, the Czech airline, mothballed one of its three Tu-104s for "economy" reasons.

However, the economy and operational efficiency trend have been strongly evident in the later generation of Soviet jet transports. The Tu-104B, which is operating at almost its full capacity on current runs, is a money maker, Aeroflot claims (AW June 29, p. 23). The Il-18 with its 80-passenger load, normal airfield usage and better than 400 mph. honest cruise is an attractive airliner and CSA has bought it for its longer range routes. The An-10, when it proves its reliability, should be attractive to underdeveloped countries that lack modern airports. The Mi-6 twin jet 80-passenger helicopter is also an item to watch in the export trade.

Aeroflot also is badly lagging in paved runways, passenger service facilities, modern airport terminal buildings, a modern airways and traffic control system and sufficient ground handling equipment. But it is tackling all of these problems with the same dogged determination and speed with which it handled development of its jet transport family. Resident foreign airline men in Moscow are continually astonished at how fast Aeroflot can move once a problem becomes acute.

Although Aeroflot now offers major time savings over its international competitors with its Tu-104As, it can already see stiffer competition coming soon from the British Comet, French Caravelle and the U.S. Boeing 707 and Douglas DC-8 operated by foreign airlines.

The Aeroflot performance of 1959 offers convincing proof of the validity of the warning we wrote three years ago (AW July 30, p. 23, 1956):

"Keep an eye on Aeroflot. Don't be surprised if it emerges as a tough competitor in the international airline business during the next five years." —Robert Hotz

THOMAS A.

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WHO'S WHERE

In the Front Office

J. Donald Rauth, a vice president, the Martin Co., Baltimore, Md. Mr. Rauth continues as general manager of Martin's Nuclear Division. Also: **Adolph Vicek, Jr.**, succeeds **Vernon Rawlings** (AW July 29, p. 24) as director of manufacturing of the company's Baltimore Division.

George S. Schairer, vice president-research and development, Boeing Airplane Co., Seattle, Wash. Also: **H. W. Haynes**, controller.

J. C. Floyd, director and vice president-engineering of Avro Aircraft Ltd., Canada, is being transferred to Hawker Siddeley Aviation, Ltd. of England to head an Advance Projects Group for research and design studies of advanced aeronautical projects. Mr. Floyd will continue as a director of Avro.

Frank R. Palmer, board chairman, the Carpenter Steel Co., Reading, Pa. **John Moxon** succeeds Mr. Palmer as president.

Dr. Friedrich Schwarz, board chairman, and **William R. White**, president, U. S. Semiconductor Products, Phoenix, Ariz., a division of Topp Industries, Inc. Also: **Robert Rutherford**, vice president and director of engineering; **Gayle Hodges**, secretary-treasurer.

Roger V. Shields, president and general manager, General Sound Control, Inc., Los Angeles, Calif.

Vic N. Thacker, president and a director, Rotol, Inc., Arlington, Va. Mr. Thacker succeeds **Jack Staples**, who is returning to the parent company, Rotol, Ltd., Gloucester.

Frank L. Bailey, president and sales manager, and **E. Lawrence Brevik**, technical director, of the newly formed Chemical Milling International Corp., El Segundo.

Woodman Perine, vice president, Vitro Corp. of America, New York, N. Y. **James C. Tourek** has been named acting general manager of Vitro Engineering Co., replacing Mr. Perine.

Robert B. Buchele, vice president-corporate development and administration, American Electronics, Inc., Los Angeles.

Mark Kramer, vice president-public affairs, and **E. Bailey Ranes**, vice president-customer field services, Continental Airlines, Inc.

C. A. Myhre, vice president-finance, Pacific Air Lines, Inc.

R. Glenn Gorman, vice president, J. W. Clement Co., New York, N. Y., in charge of the new Clemco Aero Products Division, Compton, Calif.

Lawrence E. Walkley, vice president-operations, Westinghouse Air Brake Co., Pittsburgh, Pa. Also: **W. Lyle Richeson**, vice president and assistant to the president.

Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., New York, N. Y., has appointed the following divisional officers: **James H. Brewster, III**, vice president-marketing; **Samuel A. Ferguson**, vice president and general manager-Mountain View, Calif., operations; **Dr. Edwin G. Schneider**, vice president-research and engineering. Mr. Brewster and Dr. Schneider will have offices at the Waltham, Mass., headquarters of the division.

(Continued on page 129)

INDUSTRY OBSERVER

▶Watch for Pratt & Whitney Aircraft to get a Navy contract for nuclear aircraft powerplant development, picking up the program originally sponsored by the Air Force and canceled due to lack of funds in mid-1957. Navy work will be done at Pratt & Whitney's CANEL facility near Middletown, Conn.

▶Atlas-Able vehicle originally intended for a launching toward the planet Venus early in June now is expected to be fired in the direction of Venus sometime in September. The planet will not be in as favorable a position with respect to the earth and the probe is not expected to come as close as it would have with a June launching, but vehicle, payload, communications, guidance techniques, etc., can be tested and valuable scientific data can be gained if the shot is successful. Vehicle will carry the same solar powered "paddle-wheel" satellite intended for the June shot (AW Mar. 23, p. 33).

▶U. S. Air Force shortly will request industry proposals for a control system designed to provide rapid communications between USAF headquarters and its major operating commands. Program is identified as 473-L.

▶Indications are that Advanced Research Projects Agency will choose a Martin Titan booster as a second stage and a Convair Centaur as the upper stage for the Saturn 1.5-million lb. thrust engine cluster being developed by Army Ballistic Missile Agency. Saturn uses eight Rocketdyne engines; Titan uses two Aerojet engines, and Centaur uses two 15,000-lb.-thrust Pratt & Whitney liquid hydrogen engines.

▶Air Force test pilot time on the Republic F-105 fighter bomber has reached 2,323 hr. on 2,158 flights; nine of the airplanes now are undergoing additional tests at Eglin AFB, Fla. Republic said pilots made 47 successful spin recoveries and reported no evidence of pitchup during flights that have reached more than Mach 2 at 38,000 ft. In armament tests, the F-105 dropped 74 externally mounted bombs (some of them 1,000 lb. types) and delivered 11 internal stores.

▶Competition for systems contract for hyper-environment system in Air Force version of Project Scout program (AW June 29, p. 29) has been won by Aeronutronic Division of Ford Motor Co. (see p. 126). Program involves use of National Aeronautics and Space Administration Scout-type three and four stage vehicles, modified to USAF requirements.

▶Increased emphasis on missile defense called for by the Defense Department's new master air defense plan may enable USAF to budget funds for evaluation of its Lobar (long base radar) missile detection and tracking system against missile targets, rather than against aircraft. Original plan was to track missiles fired over Atlantic Missile Test Range but last December IT&T Laboratories Division of International Telephone & Telegraph Corp. was informed funding limitations forced installation of the test system in the New York area so aircraft could be tracked and data be extrapolated to estimate performance against missiles. Lobar system is based on Columbia University's ORDIR (omnirange digital radar) system (AW Aug. 19, 1957, p. 29).

▶Project Mercury contract between NASA and McDonnell Aircraft Corp. calls for 12 capsule systems, 12 ablation and six beryllium heat shields, six escape and six retrorocket systems, nine adapter sections, nine release mechanisms and a mockup of the capsule system. Contract totals $10.5 million.

▶National Aeronautics and Space Administration has allocated $3 million from Fiscal 1959 funds to its Jet Propulsion Laboratory for development of the storable upper stage engine for the Vega launching vehicle.

▶Electro Mechanical Research, Inc., is furnishing two telemetry systems for a prototype man-in-space capsule for National Aeronautics and Space Administration under a $120,000 contract.

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Washington Roundup

Nuclear Plane: $10 Billion?

Dr. Herbert F. York, director of research and engineering for the Department of Defense, startled House Appropriations Committee members with the price tag he put on the aircraft nuclear propulsion program. York testified: "If anything is to be done in the way of application of nuclear energy to flight, it will not be done for less than $10 billion or some multiple thereof."

Rep. Melvin Price (D.-Ill.), chairman of the research and development subcommittee of the Joint Congressional Committee on Atomic Energy, was puzzled. "I suppose it depends on how far you go in continuing to advance the art," Price commented. "I would place the achievement of a supersonic nuclear-powered aircraft at less than half of York's figure, and a missile probably could be achieved faster and for less. However, the testimony to our subcommittee is that for $1 billion additional a subsonic plane could be achieved in four years."

To date, almost $1 billion has been spent on the project. The Administration's program (AW June 29, p. 17), which has no goal for the achievement of flight, is for $600 million over the next four years—a level outlay of $150 million a year. Price wants $400 million additional put into the program and a mid-1963 target set for flight.

Seaboard's Cargo Plan

Seaboard & Western Airlines has proposed a plan for the movement of overseas logistic pipeline cargo traffic in the Atlantic area that is attracting the support of Department of Defense officials. The plan also includes immediate expansion of air lift capacity in the event of an emergency.

Essentially, the Seaboard & Western proposal calls for a long-range agreement between the Defense Department and Seaboard as well as other certificated scheduled air carriers prepared to undertake the project covering the movement of Defense Department cargo traffic on regularly scheduled operations at tariff rates filed with the Civil Aeronautics Board. Seaboard has offered to handle such traffic between Dover AFB and Mildenhall, Chateauroux and Frankfurt, for example, at rates that average 21.7 cents per ton-mile.

Since the rate has been computed on the basis of a 100% load factor, it is less than tariffs often submitted in the bidding process now used in allocating military traffic to commercial carriers. Seaboard has offered to provide 1,000 ton capacity each month both eastbound and westbound from July through October and to increase the amount to 1,250 tons monthly from November through December. When necessitated by emergency requirements, Seaboard will boost these figures by 50%.

Ex-Officers in Industry

House Armed Services Investigating Subcommittee, headed by Rep. Edward Hebert (D.-La.), will start public hearings July 7 on the hiring of ex-military officers and key civilian government officials by defense contractors with Deputy Secretary of Defense Thomas S. Gates as the first witness. He will be followed by members of Congress—all of whom have been invited to testify.

Among those who have accepted are members of the New York delegation which, 44-members strong, is pushing legislation to require more competition in negotiation of contracts, with the declared hope that this will shift defense business from the West Coast to New York areas of high unemployment (AW June 29, p. 25), including Sen. Jacob Javits (R.) and Rep. Alfred Santangelo (D.). Other Congressmen who have asked to testify are Rep. Paul Kilday (D.-Tex.), Rep. Charles Bennett (D.-Fla.), and members of the Connecticut delegation.

CAB Irritation

Civil Aeronautics Board members are showing signs of irritation over efforts by Piedmont Aviation, Inc., to assume a Capital Airlines route between Norfolk and Knoxville, before a Board decision is rendered in the Piedmont Local Service Area Investigation. The Board pointed out that Piedmont, in "extraordinary" action, joined in by Capital, had twice sought to sever this route application from the Piedmont Area Case but had been rejected on grounds that such action would tend to confuse and possibly prejudge CAB freedom to decide all issues in the area case. The Board noted that since cities on Capital's Norfolk-Knoxville route are at least getting one round trip daily schedule, while many other communities in the area case have either limited or no air service, the latter cities "are as much entitled to an expedited decision" as those on the route being sought by Piedmont.

Science Department

Sen. Hubert H. Humphrey (D.-Minn.), who last year advocated the establishment of a Department of Science and Technology, has decided to proceed slowly with the project. Legislation he now is sponsoring would set up a bipartisan commission to consider the desirability of establishing such a department. It has been approved by the Government Operations Committee.

New Job for Holaday

Power of William M. Holaday, chairman of the Civilian-Military Liaison Committee, has been expanded. The committee now will handle disputes between Defense Department and National Aeronautics and Space Administration as they arise, rather than only on request. Each agency has four members, with Holaday as tie-breaker.

Holaday recently called the committee "strictly a fifth wheel" (AW May 4, p. 25), and drafted proposals to increase its role. He now gives up chairmanship of DOD's Ballistic Missile Committee, which passes to Research and Engineering Director Herbert York, and his post as missile advisor to Defense Secretary Neil McElroy.

Travel Tax

Senate advocates of elimination of the 10% transportation tax, led by Sen. George Smathers (D.-Fla.) won only a minor victory last week. The tax rate extension measure sent to the President reduces the tax to 5% starting July, 1960. However, Rep. Wilbur Mills (D.-Ark.), chairman of House Ways and Means Subcommittee, has promised to reconsider permitting the reduction to go into effect early in the next session of Congress.

—Washington staff

Industry Questions Multi-Bid Philosophy

Spokesmen fear USAF group-bidding stand may disclose company proprietary rights to competitors.

By Philip J. Klass

Washington—Recent Air Force action on the WS-138A air launched ballistic missile and the Minuteman programs may seriously dampen industry's enthusiasm for multi-company team bids on complex weapon and support systems—a concept Air Force officials had done much to encourage.

The action (AW June 29, p. 17) represents an interpretation of existing directives rather than a new policy statement and for this reason the new ground rules are not well-defined. The action may reflect increasing congressional scrutiny of weapon system management procurement practices and their effect on competition.

The new procurement philosophy, only recently applied by Air Materiel Command's Aeronautical Systems Center in Dayton, Ohio, on the WS-138A is that an industry team does not bid as an entity, but as a prime contractor with a group of "proposed subcontractors." If the program is a major one, and the subsystems represent a sizable number of dollars, the prebid alliance is washed-out and the prime contractor must hold an open competition to select his major subcontractors, according to Brig. Gen. B. H. Warren, commander of Aeronautical Systems Center.

In the recent ALBM competition, General Electric had been invited to submit a bid for the prime contract, but decided to work with Douglas on a team basis, with General Electric serving as the avionic subsystems manager under Douglas as prime.

General Electric worked for many months with Douglas prior to submitting a proposal and had engineers stationed in the Douglas plant to coordinate the joint effort. Now Douglas has been told that it must hold an open competition for the ALBM guidance and control system, although General Electric may submit a bid along with other avionics companies.

Earlier, Air Force had told Boeing that it must hold an open competition to select companies to furnish the intra-site communications and ground checkout equipment for the Minuteman. Boeing's original proposal was based on these subsystems being provided by Radio Corporation of America and Westinghouse Electric.

In a recent competition for this Minuteman intra-site communications subsystem contract, Boeing has selected RCA, its original choice. Winner of the competition for ground checkout equipment has not yet been decided.

A Westinghouse spokesman admits that his company was "shaken up" by Air Force decision on the Minuteman because it was the first instance of this sort which it had encountered.

Industry concern over the new policy stems in part from uncertainty over the question of when and on which programs it will be applied. For example, Air Materiel Command in Dayton recently awarded a $39 million contract for the AN/ASD-1 airborne electromagnetic reconnaissance system to an eight-company team headed by Airborne Instruments Laboratory (AW June 22, p. 85) without invoking the new subcontractor competitive selection.

A spokesman for the Rome Air Materiel Area told Aviation Week that he was not aware of the new policy and that the center there had no plans to put it into effect. The Rome Air Materiel Area had awarded several large contracts in recent months to industry teams. USAF's new global communication system, 480-L, went to a four-company team headed by International Telephone & Telegraph Co., which also headed a two-company team that recently received a contract for Strategic Air Command Control System. In neither case was IT&T told to hold open competition to select its teammates.

Gen. Warren points out that the Air Force always has insisted upon its right to accept or reject any company's choice of subcontractors. He further cites a statement of policy in a letter which Air Force sent to various industry associations last October on the subject of joint-company proposals. The letter stated: "The Air Force reserves the right to accept or reject proposals as a whole, or any part thereof, that may best serve to fulfill our requirement. . . . It may be necessary to accept portions of two or more combined proposals . . . effecting different combinations (of companies) before final selection of all contractors involved is accomplished. . . . Liability of a combination leader to associate contractors in case changes are required . . . must be worked out by the contractors themselves."

Industry spokesmen do not question the USAF's right or need to approve a prime contractor's choice of major subcontractors, based on their competence, capability or responsibility. Furthermore, industry generally recognizes that the Air Force may find a novel idea or approach in a losing proposal which it would like to have incorporated in the winner's design.

What industry spokesmen do question now is the wisdom of their spending time and money in working with

Polar Orbit Satellite

Washington—Target date of Advanced Research Project Agency's polar orbit communication satellite launching (AW June 29, p. 18) probably will be moved back to ensure compliance by contractors and other agencies involved. Systems engineering and technical direction for ARPA's three-phase communication satellite plan, involving two polar orbit vehicles and a 22,300-mi. equatorial hovering (24 hr.) vehicle, will be performed by Space Technology Laboratories, working through Ballistic Missile Division.

Communication packages for the polar satellites will be supplied by Wright Air Development Center's Communications & Navigation Laboratory, while Army Signal Laboratories is scheduled to supply the avionic package for the 24-hr. satellite.

Convair has responsibility for supplying the propulsion system to boost the satellites into orbit, but details of its total responsibility in the program are not yet specifically defined.

Satellite Atomic Clock

Washington—Hughes Aircraft Co. has been awarded a $200,000 National Aeronautics and Space Administration contract for a 30-lb. Maser atomic clock that will be used in an orbiting satellite to test Einstein's general theory of relativity (AW June 22, p. 140).

Prototype now is being constructed at Hughes Research laboratories in Culver City, Calif., under the direction of Dr. Harold Lyons, head of the atomic physics department and inventor of the first atomic clock. National Bureau of Standards and Massachusetts Institute of Technology also are developing atomic space clocks for NASA (AW May 25, p. 37). Operational life of the Hughes clock will be 500 hr. It will resemble a 1-ft. long electron tube and will house a stream of ammonia molecules. Accuracy will be within three seconds in 100 billion.

companies who are preparing prime contract bids, when they will have to go through the same procedure again when the subcontractor competition is held.

Spokesman for one large avionics company that has been hit by the new policy says: "In the future, we'll keep our good ideas to ourselves until after the prime contractor has been selected. Otherwise we may find our novel ideas disclosed in the specifications to which we and our competitors are asked to bid for the subcontract."

One General Electric spokesman, expressed concern that in the competition to pick a control and guidance system subcontractor for the ALBM, "Douglas may have to bend over so far backward to avoid criticism that we'll have to submit twice as good a proposal as our nearest competitor to win."

Gen. Warren says that the Air Force's policy of requiring open competition for major subsystem awards is part of continuing effort to avail itself of the best that industry can provide at the lowest cost to the government. The General said he strongly believes that a weapon system prime contractor should take a fresh look at major subsystem sources after the contract award, some of which may not have been available to him earlier because they were teamed up with one of his competitors.

However, industry spokesmen point out that many avionics companies are willing to submit proposals to as many prime bidders as are willing to accept them. For example, in recent WS-138A competition, more than half of the prime bidders included a Kearfott inertial guidance system.

The new procurement policy may have significant impact on both airframe and avionics companies, some observers believe. If it breaks off the prebid efforts between airframe and avionics manufacturers, Air Force evaluation teams may find themselves with only a skeleton of detailed information on which to judge the relative technical merits of competing prime bidders. This would be ironic, inasmuch as Air Force officials have encouraged such joint prebid efforts in the past.

If this takes place, observers contend, it would force airframe manufacturers to expand their own in-house avionics capability in order to fill in the voids in their proposals.

Another likely consequence is that more of the major avionics manufacturers will bid for weapon system prime contracts than in the past. For example, as a result of the WS-138A situation, General Electric will bid as a prime for an Airborne Long-Range Intercept system to be used on airborne early warning aircraft to extend the range of air defense radars. Earlier, General Electric had planned to bid with an aircraft manufacturer.

Atlas Fuel Flow Problems Delay Operational Capability 60 Days

By Evert Clark

Washington—Fuel flow problems that have caused the last two USAF-Convair Atlas missiles to explode in test flights have resulted in an extensive search for the cause of the trouble and have delayed the initial operational capability date by at least 60 days.

Defense Secretary Neil H. McElroy noted that the last five Atlas shots have failed and revealed the two-month delay. He did not say in what technical area the trouble had occurred and did not explain that the fuel flow problem now concerning technicians on the project was responsible for only the last two of the five failures. McElroy added that Soviet Russia has had "serious delays" in her intercontinental missile program.

Atlas Firings

Atlas has been fired 25 times. Ten shots have been classed as successful, six as partially successful and nine as unsuccessful. The last five missiles—fired on Feb. 20, Mar. 18, Apr. 14, May 19 and June 6—have exploded in flight.

The February and March shots were the last two missiles in the C series. Cause of failure in each case was classed as random.

The last three shots have been D models, which is the operational configuration. Cause of failure in the first D shot was one of two hold-down arms on the launcher, used to retain the missile until booster engine thrust builds up sufficiently for liftoff. They push against the missile with a pressure of 8,000 psi., which decays to 4,000 psi. in approximately half a second at the proper time, allowing the missile to pull free. In the abortive firing of the first D, one arm hung too long and damaged the glass fiber skirt around the booster portion of the missile.

The next two D shots failed because of a malfunction, still not precisely located, somewhere in the propellant flow system. Although pressure decayed too rapidly in the liquid oxygen tank and the fuel tank, causing the bulkhead between them to reverse, pressurization of tanks has been absolved of blame and the trouble is believed to be farther along in the flow process.

An extensive checkout program to locate the cause of failure has included driving pressurized Atlases over roads; shake and drop tests and deliberate misalignment of components.

About mid-July another D shot—the first of about four aimed at pinpointing the trouble—will be launched with the suspect areas heavily instrumented.

The difficulty is considered to be one that could have occurred at any point in the missile's development cycle, and is the type of problem that could be expected when a change-over in models is made from one series to another, but it occurs at a critical time from the political point of view.

The Atlas testing schedule had been compressed considerably in an attempt to fire at least one D model successfully over the Atlantic Missile Range and then another from the operational training base at Vandenberg AFB, Calif., before the end of Fiscal 1959 so that Atlas could be called "initially operationally capable."

Failure to fire a D model successfully from Cape Canaveral, Fla., therefore delayed the Vandenberg firing. This has resulted in one unexpected advantage—gain of enough time to install automatic ground equipment at Vandenberg that would not have been ready if the initial shot there had been fired by June 30.

Time Lag

McElroy, revealing the delay after an annual Defense Department Secretaries' conference at Quantico, Va., discounted the importance of the time lag as far as a development race with Soviet Russia goes.

"We believe that they (the Russians) have had serious trouble," McElroy said. "Whether they have worked out of it, we don't know, but I would be inclined to believe from the intelligence estimates that they will probably just about make what has been expected of them."

This expectation, he said, was that Russia would have about 10 operational ICBM's by the end of this year. He said it is not important whether Russia has 10 or 100 missiles, adding: "The important thing is when they get enough to cream the country."

HU2K's First Flight

Kaman HU2K turbine-powered utility helicopter for the Navy made its first flight last week. The helicopter, powered by the General Electric T58 engine, is Kaman's first tail rotor helicopter. Other Kaman designs having used twin main intermeshing rotors.

The No. 2 production ship made the flight. The No. 1 ship still is undergoing tie-down tests. Kaman also has built a static test ship (AW June 8, p. 86).

Vinson Opposition Spearheads Renegotiation Amendment Cuts

By Katherine Johnsen

Washington—Aircraft firms challenging determinations of excessive profits by the Renegotiation Board in the U. S. Tax Court received a setback last week when Congress rejected all amendments which would strengthen the position of petitioners in approving a three-year extension of the renegotiation law.

North American Aviation, shortly before this action, filed a case in the Tax Court against a Board determination of $3.5 million excessive profits for 1955. This brought the total value of cases by aircraft firms pending in the court to more than $75 million.

As presented by Rep. Carl Vinson (D.-Ga.), chairman of the House Armed Services Committee, the seven firms challenging the Board's profits determinations are:

Boeing Airplane Co., $26.8 million; North American Aviation, $21.2 million; Douglas Aircraft Co., $8.7 million; Grumman Aircraft Engineering Corp., $6.7 million; Lockheed Aircraft Co., $4.2 million; The Martin Co., $3.2 million; Temco Aircraft Corp., $4.8 million.

The Tax Court has generally upheld the excess profits findings of the Board. Nineteen cases have been decided in the court since the establishment of the Board in 1951. In two cases, the determinations of the Board were sustained. In one case, the profits determination was reduced by the court and 16 cases were dismissed at the request of the petitioning contractor.

These are the changes, originally voted by the House 379 to 133, but killed in final congressional action last week, which would have strengthened the position of contractors in court cases:

- **De-emphasize the weight** now given by Renegotiation Board in reducing profits to the public capital investment, amounting to more than $1 billion for the aircraft industry.
- **Give special consideration** to profits earned under incentive type contracts, widely used in aircraft and missile manufacture to encourage cost savings by the incentive of greater profits.
- **Require the Board** to supply a contractor with a statement detailing the weight it gave to various factors—amount of private investment, efficiency of production, etc.—before issuing an order for a refund of profits or seeking agreement on a refund.
- **Permit a contractor** to inspect all material furnished the Board by Department of Defense or other agency for which the renegotiated contracts were performed.

This is pertinent to the Boeing case now awaiting a Tax Court determination as to whether records of the Air Force and Renegotiation Board may be subpoenaed by Boeing in connection with the proceedings.

- **Direct that the Tax Court** shall attach no "presumption of correctness" to Board determinations, as it does at present.
- **Provide for appeals** of Tax Court findings to the U. S. Court of Appeals.

Elimination of these changes to existing renegotiation law was largely a one-man victory for Rep. Vinson, who vigorously opposed them in testimony before the Senate Finance Committee after they had been overwhelmingly voted by the House (AW June 8, p. 26).

The House-Senate conference report does state that "no inference is to be drawn, with respect to the rights of contractors and subcontractors—whether in pending cases or otherwise—from the

Douglas Proposes Turbofan Cargo Plane

Santa Monica—Douglas Aircraft Co., utilizing design information gained in its DC-8 turbojet transport development program, has proposals for a pair of cargo airplanes for the 1965 era, both powered by turbofan versions of the Pratt & Whitney J75 turbojet engine.

The airplanes, one military, the other for commercial applications, show the DC-8 family resemblance through general configuration, retaining the 30 deg. sweep angle of wing and tail surfaces. But while the commercial airplane has its four engines podded singly, the military version uses one pod per wing with two engines per pod, similar to the inboard nacelles of the Boeing B-47. Both airplanes use the swing tail principle.

Military aircraft, termed the "CX," would have a takeoff gross weight of 480,000 lb., with the four TF75 (JT4D) engines generating 25,750 lb. wet thrust each for takeoff. Takeoff roll distance per military specification would be 5,040 ft., while a 50 ft. obstacle clearance would require 7,050 ft.

The wing would have 4,500 sq. ft. area and would employ high lift devices on leading and trailing edges. Aspect ratio would be 7 and planform would differ slightly from the conventional, especially in the wing root fillet area around the leading edge.

Airplane specifications indicate the wingspan is 177 ft. Plane length is 167 ft. while height to tip of vertical tail is 58 ft. 7 in. Normal floor height is 11.3 ft. which reduces to 5 ft. (truck bed height for straight-in loading) by means of a kneeling landing gear.

Fuselage length is 121.2 ft., with the cargo compartment being 95.5 ft. long, 11.7 ft. wide and the same dimension high. Volume is 14,600 cu. ft., and density would be 7 to 10 lb. per cu. ft., giving the aircraft a capability of carrying all modern military vehicles.

The airplane would be capable of meeting a general requirement of carrying 100,000 lb. transatlantic and 50,000 lb. transpacific. Specific ranges shown are, at normal takeoff gross weight, 100,000 lb.—4,300 naut. mi.—60,000 lb., 6,000 naut. mi. Average cruise altitude would be 30,000 ft.

True airspeed would be 460 kt., or Mach 0.8. Design load factor is 2.5g positive, 1g negative.

Second airplane, the "CX-Junior," intended for commercial airline operators, would use the same engines and again have the DC-8 family resemblance but would be smaller and lighter than the military ship.

Normal takeoff gross weight would be 375,000 lb., takeoff roll (again according to military specification C5011A) would be 4,450 ft. for normal takeoff and 6,000 ft. over a 50 ft. obstacle.

Wing area would be 3,000 sq. ft. and have the same 30 deg. sweep at quarter chord for wing and horizontal tail, and planform again would change slightly to use advanced leading and trailing edge high lift devices. Aspect ratio remains 7. Wing span is 144 ft. 11 in.

Over-all length would be 163 ft. 4 in. and height to top of vertical tail would be 46 ft. 8 in. Main truck wheel tread would be 24 ft. Fuselage floor height would normally be 9.5 ft., reducing to the 5 ft. standard truck height for straight-in loading, again using the kneeling landing gear technique.

Cargo compartment volume would be 11,500 cu. ft., be 95.3 ft. long, 11.3 ft. wide and 10.0 ft. high, with the same density capability.

For the commercial application, range would approximate 3,700 naut. mi. with an 80,000 lb. cargo load. Speed would be 480 kt. true, or Mach 0.82. Initial cruise altitude would be 28,000 ft.

fact that provisions" included in the House measure were eliminated.

The report continued: "For example, section four of the House bill provides that a contractor may inspect certain documents in the possession of the renegotiation Board. The fact that section four of the House Bill is not included in the bill as agreed to . . . should not be construed as affecting in any way any right which a contractor may have under existing law or legal processes to obtain such documents or any other data."

The extension measure sent to the White House for the President's signature also provides for a two-phase major congressional study: first, of procurement, and then of renegotiation (AW June 15, p. 85). Senate Finance Committee observed that "a comprehensive appraisal of renegotiation can be made only by considering the operation, use, and effectiveness of various procurement policies, practices, and methods." The procurement study will be made jointly by House and Senate Armed Services Committees; the renegotiation study by the Joint Committee on Internal Revenue Taxation.

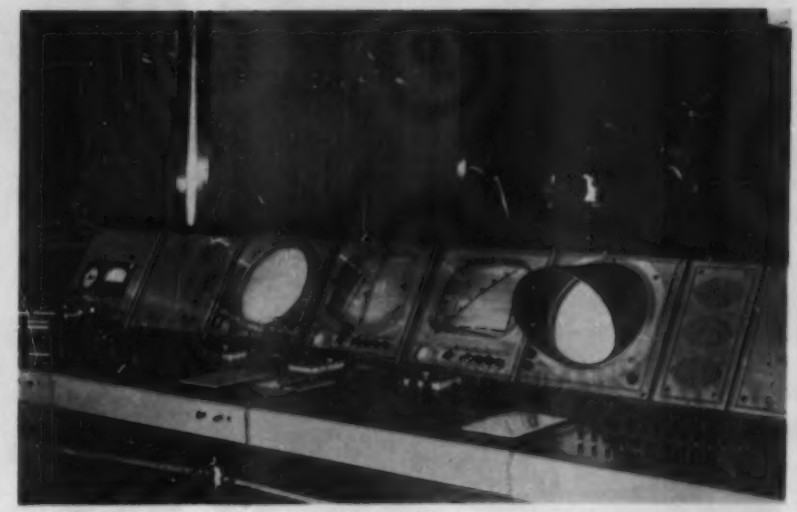
Senate Finance Committee, in its report on the three-year extension law, noted that "renegotiation of government contracts requires the exercise of an unusually high degree of administrative discretion and judgment on the part of men rather than the application of fixed and determinable rules of law.

"Recognizing this . . . the statute granting this unusual authority should not become a permanent part of our law but should be extended only on a temporary basis so that the Congress may have the opportunity periodically to review the exercise of that discretion in the light of its impact on the interests of the government and contractors alike."

French Space Program

Paris—French cabinet last week approved a $50 million space program which will include initial development of a missile carrier capable of placing a small satellite in orbit. Most of the $50 million—which will be spent over a four-year period—will be used for development and improvement of French test missiles already in use as the single stage Veronique and three-stage Monica types.

These missiles currently are being fired at the government missile center in Colomb-Bechar in a program designed to explore the region between 30-150 mi. The space program should result in closer coordination between various government and private groups in the space field.



APPROACH CONTROL console displayed at the Soviet exhibition in conjunction with model airport mounts TV-type ASR scope at left, two PAR scopes and taxi radar repeater.

Soviets Show Mechta Last Stage, And Airport Model at Exhibition

New York—Soviet Union's $3 million Exhibition of Science, Technology and Culture which opened here last week indicates the extent of that country's technical capability. Displays at the exhibit range from chromium-plated models of the three Sputniks to a 15-ft. model of the atomic-powered icebreaker, Lenin.

One of the best attended displays of the Soviet exhibit is a model airport equipped with miniature jet aircraft taking off and landing on metal rails, complete with a tape recording of jet noise and radio conversations between pilots and controllers. Navigational aids shown in use on the model include: airport surveillance radar, precision approach radar, instrument landing system, marker beacons, approach lighting, and ground control (taxi) radar.

Working in conjunction with the model airport is an approach control console that features television-type displays of the information from the airport surveillance radar and precision approach radar. The console includes radar, an illuminated diagram of the radar display of the ground control runways and taxistrips with signal lights to indicate the active runways and similar information, and speakers for air-ground communications.

A question exists as to whether control consoles that are this modern are now in use in the USSR. Engineers at the display stated that consoles of this type are being installed at all new Soviet airfields.

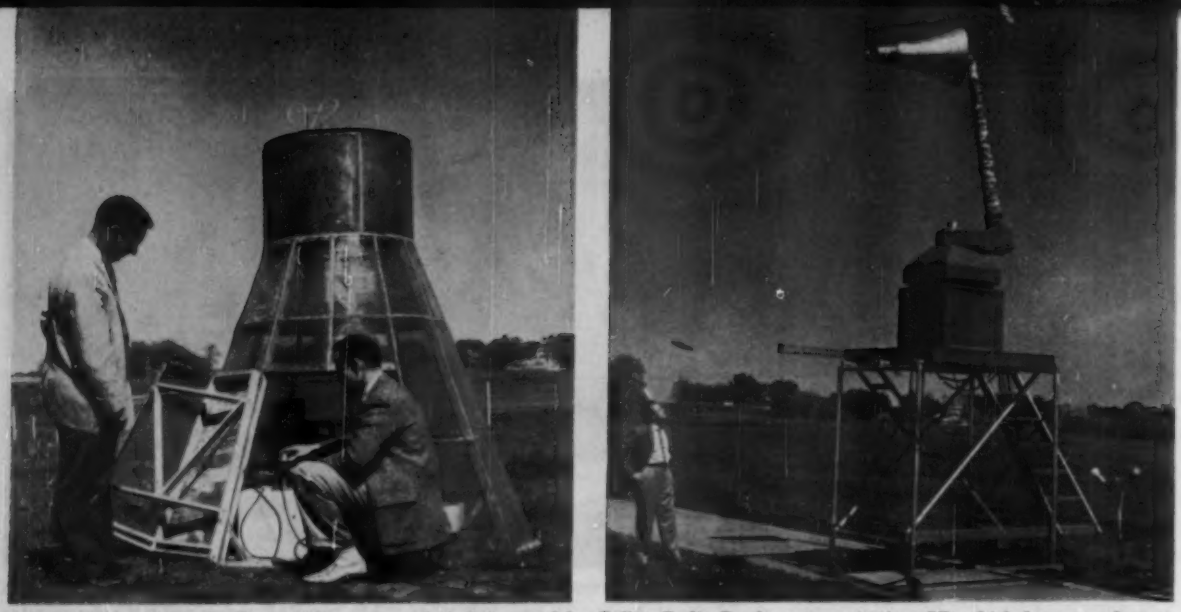
In addition to the three Sputniks, the Soviet "cosmic" rocket Mechta's final stage is on display for the first time. The model shows the complete third stage to have a diameter of about 10 ft., and to be about 20 ft. in length. Ejection ports for creation of Mechta's sodium "comet" can be seen, as well as what appear to be a mockup of the instrument package (AW June 29, p. 53) which is viewed through windows in the protective nose cone.

A model of the Soviet atomic-powered icebreaker Lenin on display included a model of a coaxial rotor, possibly turbine powered helicopter. The design is similar to the Ka-15 and Ka-18 in the rotor and twin vertical tail surface layout and may be an advanced version of a helicopter in the Kamov series. The helicopter model rested on a small flight deck area on the fantail of the ship.

Much of the electronic equipment on display consists of home radios, both with vacuum tubes and transistors, and television sets and tape recorders. Also shown are electronic analog computers, test equipment, and electronic control equipment for industrial automation. One of the more expensive television sets includes both a dual channel tape recorder for stereophonic recording and a wire-linked portable remote control unit.

The "Atoms for Peace" section of the exhibit is divided into four subsections:

- **Accelerators of atomic particles** and physical researches.
- **Thermonuclear researches.**
- **Atomic energy.**
- **Uses of isotopes** in industry and medicine.



FULL-SCALE mockup of a Project Mercury capsule is being used by Collins Radio Co. for antenna testing. Ultra high frequency descent-recovery antenna is on top of mockup (left). Antenna fairing (right) is mounted on a pattern range rotator for pattern testing.

Space Technology

First Mercury Avionic System Ready

Cedar Rapids, Iowa—First prototype of the Project Mercury communications system—designed to provide voice communications, tracking and direction finding signals, and telemetry data—is scheduled to be delivered to McDonnell Aircraft Corp., the project's prime contractor, by Collins Radio Co. late this month. Project Mercury is the National Aeronautics and Space Administration's program to orbit a manned satellite.

The complete communications system is made up of 14 avionic subsystems including:

• **Voice communications** equipment operating in both the HF and UHF ranges. The high frequency communications system will consist of an HF orbital voice communications transmitter-receiver and an HF recovery voice communications transmitter-receiver. The HF orbital voice transmitter is a conventional, partially transistorized unit with 10 watts output. The transistorized receiver employs a tuned radio frequency circuit with a crystal input filter.

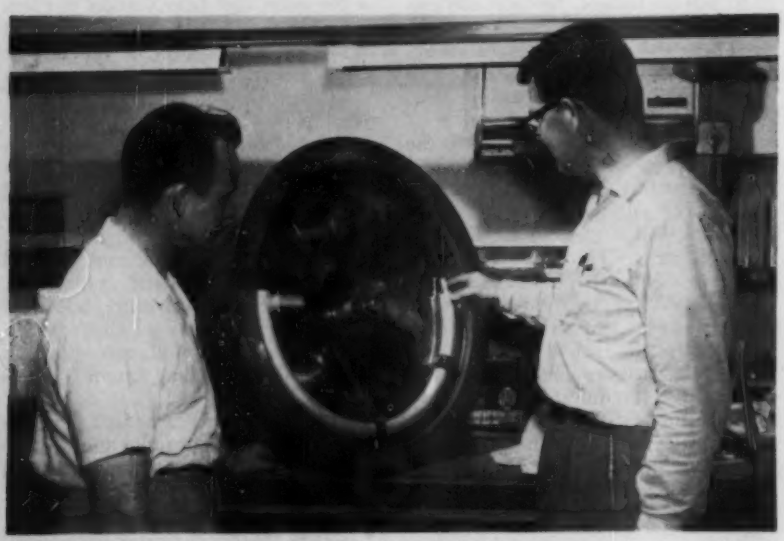
The HF recovery voice transmitter-receiver is identical to the orbital unit except that an additional 24-hr. battery pack is used in place of the capsule's central 28-v. battery supply. The power amplifier is omitted, which reduces the power output to one watt for battery economy.

The UHF orbital voice transmitter is a crystal controlled unit with a power output of two watts. The receiver is a transistorized, single conversion superheterodyne unit. The UHF rescue voice transmitter-receiver is identical except that the power output is one-half watt.

Manual controls for the communications subsystem will be provided by a common control unit which will contain audio volume controls, a switch for the UHF recovery transceiver for selection of voice or direction finding signals, a key for continuous wave transmissions, and audio mixing controls.

• **Command subsystem** will consist of two FM command receivers with paralleled inputs and outputs to provide redundant operation for command functions during launch, orbit, and re-entry. The subsystem will allow operation of 20 on-off functions, of which any six can be operated simultaneously. The audio output of the receivers will also be paralleled and available for emergency voice communications.

• **Telemetry subsystem** will consist of a high power transmitter, a low power



BICONE ISOLATOR in a full-scale model of the Project Mercury capsule antenna fairing is pointed out by Collins engineer Ramsey Decker. Fairing goes on top of capsule.

Redstone for Mercury

Washington—First modified Redstone engine for use in Project Mercury manned space flights has been delivered to Army Ballistic Missile Agency by Rocketdyne Division of North American Aviation, Inc.

Although the vehicles being prepared by ABMA for the National Aeronautics and Space Administration project are basically Chrysler Redstone missile boosters, their airframes will be lengthened by about 10 ft. to carry extra propellants and will resemble the Jupiter-C test vehicle and satellite launcher.

Only modification to the standard Redstone production engine is the addition of auxiliary peroxide tanks to permit pumping of the larger propellant supply. Engines will use Hydyne fuel and have a burning time of about 150 sec., compared with 110 sec. for the Redstone missile's engine. Thrust will be approximately 83,000 lb.

First Mercury shots with these vehicles will carry animals in Mercury capsules to an altitude of 100 mi. Later flights will be manned.

transmitter, and a power supply. The high power transmitter will be used for intermittent transmission of scientific and aeromedical data. The low power transmitter will provide continuous transmission of aeromedical data.

• **Precision tracking subsystem** consists of C-band and S-band tracking beacons. The C-band beacon has a receiver sensitivity of −65 dbm. and a peak power output of 375 w. to provide a 1,000 mi. range capability. The beacon is transistorized except for the magnetron. The S-band beacon has an identical receiver sensitivity and range capability.

A VHF orbital tracking beacon, similar to the one used in the Vanguard satellites, will be included in the Project Mercury capsule. Also included will be HF and UHF rescue beacons. The HF beacon will deliver one watt output power, while the modified SARAH UHF rescue beacon will have 15 w. peak-pulse output power.

Except for the C- and S-band beacons, one antenna will be utilized for the entire communications system during launch and orbit. When the drogue chute is ejected during re-entry, the common antenna will be jettisoned and a broadband monopole will be erected from the top of the parachute container. At this time, the UHF voice, command, and telemetry units will be multiplexed to this antenna, called the UHF descent recovery antenna.

After the capsule lands and the parachute is separated, a balloon will raise the HF antenna wire which will radiate the HF beacon and communications signals. The C- and S-band beacon antenna consists of three dual band circularly polarized radiators symmetrically arranged around the capsule. It is located below the parachute container so that it operates during launch, orbit, and re-entry and descent.

The common antenna that serves all transmitters and receivers except the two C- and S-band beacons during launch and orbit is a modified biconical horn that separates the nose cone from the capsule proper.

Subcontractors to Collins Radio Co. for the Project Mercury communications system are:

• **Audio electronic control unit:** Andrea Radio, Inc., Long Island City, N. Y.

• **Command subsystem** Motorola, Inc., Phoenix, Ariz.

• **Telemetry subsystem:** Texas Instruments, Inc., Dallas, Tex.

• **Precision tracking subsystem:** Avion Division of American Car & Foundry Co., Paramus, N. J.

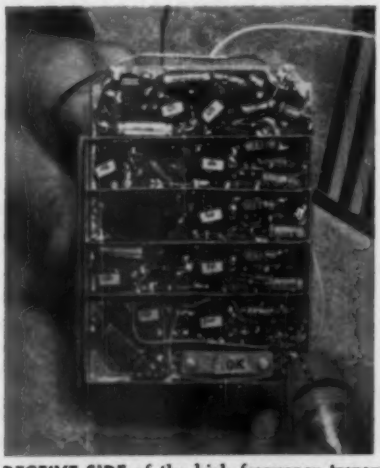
• **Orbital tracking beacon:** Cooper Development Corp., Monrovia, Calif.

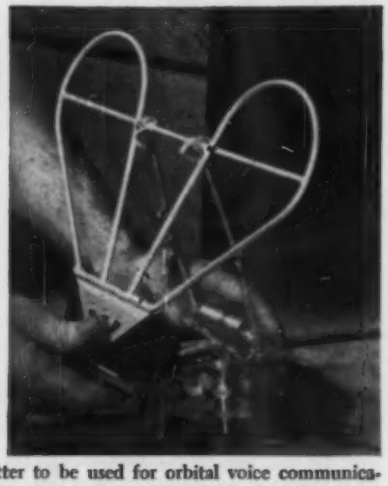
• **HF and UHF rescue beacons:** Simmons Aerocessories, Inc., Tarrytown, N. Y.

• **Bicone multiplexer:** Microphase, Inc., Greenwich, Conn.

• **Balloon system:** General Mills, Inc., Minneapolis, Minn.

• **C- and S-band antenna:** Melpar, Inc., Falls Church, Va.





RECEIVE SIDE of the high frequency transmitter to be used for orbital voice communications in Mercury capsule is shown at left. Transistorized receiver is a high-performance, tuned-radio frequency circuit with a crystal input filter. Ultra high frequency descent-recovery antenna (right) will be collapsed under antenna fairing and, when fairing is blown off on descent, will be erected as shown.

New Beech Airplane

Beech Aircraft Corp. will bring out a new, single engine, four-place airplane priced under $20,000 with its new line this fall, which also will include modifications to existing models.

The new airplane will be priced between the Piper Comanche in the $17,000 range and the Cessna 210 in the $22,000 class, John A. Elliott, Beech secretary-treasurer, told the New York Society of Security Analysts last week.

Beech expects to raise its total sales volume 15-20% in its 1960 fiscal year by virtue of the new and modified models, Elliott said, with the increase due to a considerable extent to greater commercial volume. Elliott estimated Fiscal 1959 results would include total sales of $86 million and of that $33 million would be commercial.

As to military projects, Elliott said the potential volume for the Beech KD2B-1 Mach 2 target drone for USAF and Navy has been estimated by the government at $40 million. Beech also is developing space capabilities at its Boulder facility which might result in producing space vehicle components such as fuel tanks.

Discoverer IV Fails To Reach Orbit Velocity

Vandenberg AFB—Discoverer IV did not attain "sufficient velocity" to go into orbit, according to USAF Ballistic Missile Division.

Air Force Fairchild C-119s were alerted to attempt aerial recovery as in Discoverer III (AW June 8, p. 33) but were not needed. Payload of the latest attempt was "300 plus" lb., nearly twice as heavy as the preceding mouse-carrying capsule.

The Lockheed-built second stage weighed 8,500 lb. at launch, 1,700 lb. at second stage burnout.

Next attempt to orbit biological specimens will be Discoverer VI. The fifth attempt will have objectives similar to Discoverer IV.

Senate Passes Revised Construction Bill

By Ford Eastman

Washington—Military construction authorization for Fiscal 1960 totaling $1.2 billion and reflecting the Defense Department's revised air defense plan was approved with "misgivings" by the Senate last week and sent to Conference Committee.

The bill, as passed, authorized $145 million less than the Administration had originally requested and $40.6 million less than the House had approved earlier. Of the total amount, the Air Force is authorized $792 million, the Army $182 million and the Navy $175 million. In addition various units of the reserve forces are authorized a total of $58 million.

Major Senate changes in the construction authorization bill are that it:

• **Provides for a reduction** and revision in the planned deployment of both Bomarc and Nike Hercules missile sites.

• **Strengthens the electronic** ground environment necessary to the control of weapons and air battles.

• **Requires annual prior** authorization for the design, development and procurement of aircraft and missiles.

As a result of the revised air defense plan presented to the Military Construction Subcommittee of the Senate Armed Services Committee, $17 million was cut from the Army's Nike Hercules program and $29 million from the Air Force's Bomarc program.

At the same time, the committee rescinded earlier action recommending repeal of authorization for the construction of 50 Nike Hercules batteries at 25 locations in the continental U. S. and eight in Hawaii under the Fiscal 1959 program.

Sen. John Stennis (D.-Miss.) subcommittee chairman, said the revised air defense plan would save taxpayers $1.4 billion over the next few years, but that the immediate effect would not be great since construction costs are merely the beginning of the huge expenditures necessary to place defense sights in operation.

Stennis added, however, that while the revised plan is a step in the right direction, it still leaves much to be desired in scope and content and, in many respects, represents a further compromise between the Bomarc and Nike Hercules missile systems.

The plan provides for deployment of Bomarc on the perimeter of the East and West Coasts and the Canadian border, while the Nike Hercules will continue to provide defense for urban areas and will be extended to certain carefully selected Strategic Air Command sites.

In addition, Stennis said, the plan further provides for $137 million more in funds for the Nike Zeus anti-missile missile program for engineering development type of work. This was not reflected in the construction authorization bill however, but will be contained in the defense appropriation bill which was considered in the Senate Defense Appropriations Subcommittee last week.

Stennis said the committee, while accepting the plans and amending the construction authorization bill accordingly, still has some reservations about the premises and philosophy employed.

"For instance," he said, "the committee questions whether too much reliance is being placed upon defense as compared to sharpening our offense with modernization of the Army, the fleet, and perhaps more emphasis on manned interceptors. It still feels the best defense is a strong, effective offense. We have emphasized that concept for years."

Stennis said the air defense plan was necessarily hurriedly considered in order to get it before the committee in time to amend the construction authorization bill. Because of the hasty preparation, Stennis said a section was added to the bill requesting the Defense Secretary to appear before both the House and Senate Armed Services Committees not later than July 31 to report on the following:

• **"The feasibility of expediting** the Bomarc program and utilizing its greater potential coverage and economy of operation in lieu of certain originally proposed Nike Hercules installations.

• **"The results of a complete** review of all previously programed missile sites with assurance that the selection of those sites to be constructed was made strictly on the basis of military priorities.

• **"The opinion of the respective** Chiefs of Staff on the authorized program for the defense of Hawaii with their recommendations if any, for modification or change in emphasis and corresponding adjustment of such program.

• **"The latest information** on the progress of anti-missile programs with recommendations, if any, for expediting them.

• **"The latest opinion** of the respective Chiefs of Staff with respect to the nature of any military threat to the security of the United States in the next five years and their judgments as to whether it is best met by continuing military programs as presently authorized, or whether certain changes should be made in that programing."

The report that accompanied the authorization bill to the Senate floor said that it is the committee's view that with technological advances, the intercontinental ballistic missile is increasingly becoming the primary threat to cities and offensive forces.

"Nevertheless," the report added, "it is recognized that the airbreathing threat will be a real one for a considerable period of time and the defense against manned aircraft and airbreathing missiles should be provided in locations and by the type of weapons that offer multi-purpose protection of cities, strategic bases and other vital facilities."

While further review of the over-all air defense plan is being made, the report urged the Secretary of Defense and Joint Chiefs of Staff to take the following actions:

• **"Proceed with all possible** haste with the Nike Zeus and all other anti-missile missile possibilities. No time must be lost and every emphasis must be placed upon some kind of anti-missile missile.

• **"Carefully review again** the proposed program (outlined in the authorization bill) before construction is begun on new sites . . . and that full consideration be given to all sites originally contained in the program with a view of selecting for development only those of the highest military priority.

• **"Careful consideration** should be given to expediting the Bomarc program in certain selected areas as recommended in the Furnas report.

• **"Particular attention** should be given to the early completion of Bomarc sites in those localities where Nike Hercules sites are proposed as a stopgap measure."

Defense Budget Raised

Washington—Total U. S. defense budget last week was set at $39 billion by the Senate Defense Appropriations Subcommittee. Measure now goes to the full committee and may be reported to the Senate floor this week.

Measure includes $11 million for 11 Fairchild F-27 turboprop transports for U. S. Air Force, although a USAF request for 10 turbojet cargo planes was turned down. Under the existing bill, Air Force gets $4.316 billion for aircraft procurement, and another $2.552 billion for missile procurement.

Navy aircraft procurement will cost $1.950 billion and Army's missile appropriation is $1.450 billion. Entire measure is $345,739,000 more than the Administration requested, and $745,600,000 more than was approved by the House.

In one section, the Senate upgraded a House appropriation for $80 million to Military Air Transport Service for purchase of space on commercial aircraft. New figure is $150 million.

J85 Specifications Revealed

First specifications for the General Electric J85-5 and J85-7 engines were revealed last week. The engine has applications in the Radioplane XQ-4B supersonic drone for USAF, the Northrop T-38 trainer and N-156 light fighter, and the McDonnell GAM-72 Quail.

The J85-5 engine used in the two aircraft and the drone is available in either missile or aircraft configuration and with afterburner. The non-afterburning J85-7 used in the Quail is a missile engine only.

These will be the production engines and will have eight-stage compressors. The J85-X, J85-1 and J85-3, which have seven-stage compressors, are considered interim models, General Electric said. The J85-7 completed its 15 hr. qualification test early this year. Only the J85-1 has completed its 50 hr. qualification test.

The specifications:

	Sea Level Static —5	Standard Day —7
Thrust (lb.) max. with afterburner	3850	.....
Thrust (lb.) military	2500 lb.	2450 lb.
Engine weight	525 lb.	325 lb.
Specific weight	.136	.132
Power to weight ratio	7.3 to 1	7.5 to 1
Over-all length	104 in.	42 in.
Dia. max. flange	20.3 in.	17.7 in.
Configurations	Both	Missile

FAA Aligns Pilot Age, Training Regulations for Jet Age Demands

Washington—The Federal Aviation Agency last week announced a series of proposed regulation changes designed to bring pilot training and age limitations in line with the more critical flight demands of commercial jet aircraft.

One of the suggested amendments would establish maximum age limits at which airline pilots may undertake jet training and impose a mandatory retirement age, while the other would provide for FAA-approved flight training programs and tighter qualifications for copilots holding second in command authority.

Air Line Pilots Assn. officials contacted by AVIATION WEEK declined to comment on any phase of the proposed regulation changes.

However, it is known that ALPA has long favored more demanding flight qualifications for copilots in the interest of greater cockpit safety.

Under Parts 40, 41 and 42 of the Civil Air Regulations, governing the certification and operation of all air carriers, FAA proposes to set 55 as the age prior to which a pilot must obtain a type rating for turbojets in order to act as a pilot in command, and age 60 as the maximum he may attain in this capacity on piston or jet equipment.

In selecting the age 55 limit for jet training, FAA pointed out that while there is no precise determination of the exact age at which pilot proficiency may become a flight hazard, "It is known, however, from available studies which have been made, that the detrimental effects on physiological and psychological functions have become significant by age 55."

For similar reasons the agency said it proposed adopting the age 60 retirement for airline pilots. FAA said that because of relatively recent large scale expansion of airline operations, and an attendant emphasis on the youth of pilots selected, the problem of pilot age and its effect on piloting skills, has not until now become of critical importance. Twelve years ago there were no active airline pilots aged 60 or over, while, by 1962, it is predicted there will be at least 80 in that age group and 250 by 1967, the agency said.

To provide a closer working relationship between the FAA and the airlines in flight crew training, the agency plans to require the carriers to submit their training programs to the FAA for review and approval. Existing regulations follow this procedure only in the case of aircraft simulator programs.

Noting that it has had the matter of higher copilot qualifications under study for some time, the FAA said it proposes that copilots be required to hold a type rating on the particular aircraft to which they are assigned and be given a six month proficiency check by a company check pilot or an FAA inspector.

This change is particularly necessary, the agency pointed out, because of the complexity of present day aircraft and supporting navigational and communications systems, in addition to the possibility that the pilot in command may be incapacitated in flight.

Recognizing the scheduling and training problems which the proposed amendments may cause, the FAA said it would not make the changes effective until six months after adoption.

News Digest

Lockheed F-104G jet fighter has been selected to replace Canada's eight North Atlantic Treaty Organization Sabre squadrons within two years, according to Defense Minister George Pearkes. Plane, similar to that adopted by West German air force (AW Feb. 16, p. 33) will be powered by General Electric J79 engine. Pearkes said negotiations are underway with Lockheed to build the F-104G in Canada. He said the Starfighter was selected from more than 20 British, American and European fighters which had been considered (AW June 29, p. 15).

Maj. Gen. John W. Sessums, Jr., vice commander of USAF's Air Research and Development Command since September, 1954, retired last week after 33 years' service, most of it in research and development. Gen. Sessums was awarded the Distinguished Service Medal, highest military peacetime award.

General Electric T58 shaft turbine engine commercial version was certificated last week by the Federal Aviation Agency. The engine is designated CT58-100-1. Guarantees are 1,050 eshp. for takeoff, 900 eshp. continuous, specific fuel consumption of 0.64 at takeoff rating and 0.67 at continuous rating, and weight of 280 lb.

Backlog of orders for complete aircraft, engines and propellers during the first quarter of 1959 totaled $12,705 million, according to FAA.

Lycoming Division of Avco Corp. has received a $24,746,315 USAF contract for production of 860 shp. T53 turboshaft engines for USAF's Kaman H-43B and Army's Bell HU-1, and 960 shp. turboprop T53s for Army's Grumman AO-1. Deliveries are scheduled to begin in September.

Bell Helicopter Corp. has received a Navy contract to build and test two HUL-2 helicopters. The HUL-2, an advanced version of Navy's Bell HUL-1, will be powered by a 250 shp. Allison YT63-A-3 turboshaft engine.

AEROFLOT'S latest gas turbine powered trio is shown on the ramp at Vnukovo Airport, Moscow's commercial terminal. From left, they are: Tu-104B 100-passenger version of the Tupolev series; Il-18 turboprop transport with 80-passenger capacity in current service versions, and the An-10A turboprop transport designed specifically for use off grass fields. Note the air conditioning unit hooked into the Tu-104B cabin and the washed down wingtips of the An-10A from the outboard engine nacelles to the tips, one of several modifications designed to improve stability that were made along with the addition of two vertical tail fins.

Aeroflot Pegs Future to Turbine Aircraft

Soviet airline aims at flying one-third of its total ton miles on turbine powered equipment by end of 1959.

By Robert Hotz

Moscow—Aeroflot is now operating the world's largest airline fleet of gas turbine powered transports. By the end of June the Soviet airline was using nearly 200 turbojet and turboprop powered transports in scheduled passenger, cargo, mail and training operations. It services a dozen foreign capitals with jet transport service from Moscow.

Continued expansion of Aeroflot's jet fleet is scheduled during the summer and fall, aimed at a goal of flying one third of the airline's total ton-miles on gas turbine powered equipment by the end of 1959. During 1958, Aeroflot carried 18% of its traffic load on jets compared with only 5% in 1957.

Aeroflot, which began scheduled passenger jet service in the fall of 1956 with a half-dozen 50-passenger Tu-104 transports, has expanded its current jet fleet to include:

• **More than 100** early model Tu-104s, including the 70-passenger Tu-104A which now is the backbone of its international jet service to Europe and Asia.

• **About 20 Tu-104Bs,** carrying 100 passengers in a high density seating arrangement over 400-1,500 mi. route segments. The Tu-104B is powered by improved models of the AM-3 axial flow turbojet rated at 15,000 lb. thrust for commercial operations. Better service life and lower fuel consumption are the main features of the new AM-3 models. The Tu-104B is scheduled to be the standard Aeroflot turbojet airliner and has superseded the four jet Tu-110 powered by four 11,000 lb. thrust Lulko turbojets. Aeroflot officials said the Tu-110 development had been abandoned after its initial test operations and the successful development of the Tu-104B.

• **More than 50 Ilyushin Il-18s** carrying 80 passengers in current Aeroflot service. First 20 Il-18s were alternately powered by competitive 4,000 eshp. turboprops designed by Nicolai Kusnetzov and Alexander Ivchenko. The Ivchenko AI-20 turboprop won the extensive service test competition and will be used exclusively on production Il-18s. The Il-18 is designed for medium range domestic and international services on route segments beyond the Tu-104 range (about 1,500-2,700 mi.) where paved runways are available.

• **Approximately 25 An-10** and An-10A 85-passenger turboprop transports that are still in the cargo service "shakedown" phase on routes in the Ukraine. An-10 was designed as a combination cargo-passenger transport with truck bed level loading floor and landing gear suitable for grass field use. The An-10A shows several major modifications from the prototype An-10 including addition of two vertical fins and pronounced washed down wingtips extending from the outboard engine nacelles. An-10A is scheduled to begin passenger service on the Kiev-Moscow run and Ukrainian routes by fall. A larger version, the 100-passenger An-16, also is under development.

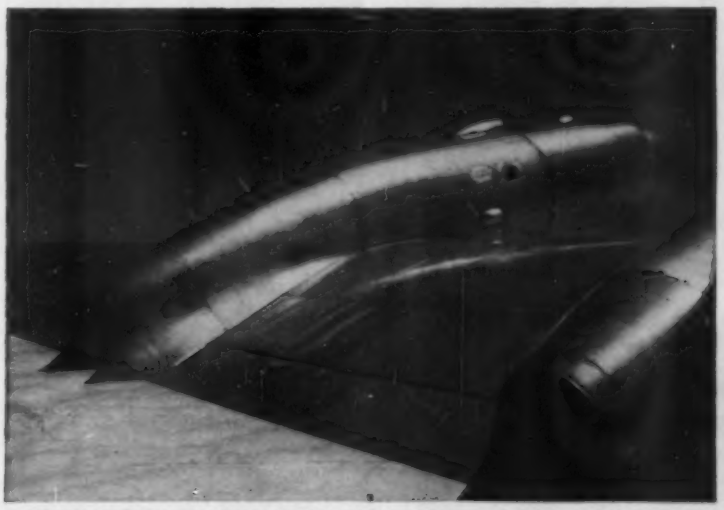
• **At least four Tu-114** giant turboprop transports now in the final phases of operational shakedown and route checks. The Tu-114 powered by four NK-12 turboprops developing 12,000 eshp. will be used by Aeroflot in three seating configurations: 220 passengers for short haul, extremely low fare tourist class service; 170 passengers for the Trans-Siberian service and 120 passengers for long range international routes including the 4,200 mi. Moscow-New York route. The Tu-114 has been engaged in operational tests for more

Aeroflot Series

This is the first of a series of articles on the operations and future plans of Aeroflot, the Soviet airline, by Aviation Week Editor Robert Hotz, based on a 6,000 mi. trip around the Soviet Union in the airline's latest turbine transports, including the Il-18 and Tu-104B and interviews with Aeroflot officials in Moscow. Mr. Hotz provided Aviation Week with similar on-the-spot coverage of Aeroflot three years ago from Moscow when he reported on the Soviet airline's plans to jump into the jet transport era, expand its international routes to the major capitals of Asia, Europe and North America and develop a family of gas turbine powered transports.

SIDE VIEW of Il-18 at Vnukovo Airport ready for departure on the Alma-Ata 2,100 mi. nonstop run shows turboprop engine installation, four wheel bogie main landing gear and relative size of the 80-passenger transport in proportion to crew group around the nose.

SIMPLE and neat group of instruments is shown in roomy Il-18 cockpit (left photo). Note radar installation with scopes at top and center of the instrument panel. Engine instruments are grouped on the center panel with dual flight instruments on each side, including an ILS type cross pointer indicator. Single control throttles for turboprop engines are mounted on pedestal in foreground. Five abreast seating is shown (right photo) in the main 55-passenger section of the Il-18 cabin. Note low overhead clearance and oriental carpet on the aisle. Seats recline and have swivel overhead lights, air vents and stewardess call buttons.



CLEAN installation of Ivchenko 4,000 eshp. turboprop is shown (left photo) in this picture taken in flight en route between Moscow-Alma-Ata. Workmanship on engine nacelles and wing structure is equal to any similar Western equipment. Aeroflot stewardess (right photo) wearing the new blue-trimmed-with-gold uniforms of passenger attendants on the jet transport service is shown preparing a meal in the Il-18 galley located in the turboprop plane between fore and aft passenger sections. Plastic trays and dishes are used for meals which are prepared on the ground and kept hot in galley ovens. Galley has the highest noise level in the Il-18.

LINEUP of four Il-18 turboprop transports (straight tail), three Tu-104 twin jets (swept tail) and an Il-14M piston engine transport (center) is shown at Moscow's Vnukovo Airport. Aeroflot pilot is in foreground.

than a year and top Aeroflot officials make no secret of their feelings that this will become the workhorse of the Aeroflot jet fleet of the future. The Tu-114 has a top speed of 540 mph. and a normal cruise of 450 mph. It is scheduled to begin Aeroflot service on the 4,300 mi. Moscow-Khabarovsk run this fall.

Aeroflot also has pushed its equipment expansion program at the opposite end of the technical spectrum to develop its short-haul and feederliner service. These developments include:

• **Beginning of scheduled** transport helicopter operations with the Mi-4 10-passenger single rotor helicopter in the Crimean and Georgian resort areas, linking major terminals with nearby resorts over mountain ridges. Aeroflot also is expanding its use of helicopters for mail delivery in Siberia with the Ka-15 and is planning a shuttle with 30-passenger twin rotor Yak-24 helicopters between Vnukovo Airport and downtown Moscow.

• **Use of the An-14** six passenger twin engine STOL transport as a feederliner to link small Siberian communities with major air terminals. An-14 has just completed its service test trials and is scheduled to begin Aeroflot feederliner service this summer.

• **Development of new feederliner** equipment to replace the An-2 single engine biplane and the Czech Super-Aero twin engine light transport now in widespread Aeroflot service. Soviets are evaluating the new Czech Morava five passenger transport for possible purchase and have given the Soviet aircraft industry a requirement for development of a new 26-30 passenger feederliner.

Aeroflot has combined its major equipment expansion program at both ends of the technical spectrum with a domestic and foreign route expansion program and a sales drive that has produced Russian versions of all standard western airline passenger service appeals, from nattily uniformed stewardesses, hot in-flight meals, travel posters and baggage stickers to fare differentials aimed at tapping the mass travel market.

Aeroflot also enforces a no-show penalty of 25% of the ticket value but not more than 280 rubles.

Route expansion is aimed at adding 25,000 mi. of new internal routes during 1959, largely in Siberia and Central Asia where the large numbers of Il-14s, Il-12s and Li-2s now being displaced on major routes by jets can be deployed to communities now without air service.

Latest international route expansion was marked by the opening of the London-Moscow service on May 14 and signing of a Soviet-Austrian bilateral on June 6 providing for reciprocal Moscow-Vienna services. Aeroflot officials make no secret of the fact that their next international expansion goal is a Moscow-New York route followed by opening services to South America.

Several weeks before the Moscow-New York nonstop flight of the Tu-114 with Deputy Premier Frol Kozlov and its designer Andrei Tupolev, and his wife, the deputy chief of Aeroflot's foreign section V. V. Ribulkin told AVIATION WEEK, in an interview at Aeroflot's Moscow headquarters, that "active technical preparations were now being made for a New York service."

TYPICAL GROUP of Aeroflot domestic service passengers is shown loading aboard an Il-18 on the Alma-Ata service. Note low cabin entrance door compared to passenger on top step. Loading stairs are self-propelled. Airport attendant checks boarding passes at the stairs.

Other Aeroflot officials indicated that once the Tu-114 test program had been completed, active negotiations would begin for a U.S.-USSR air agreement as provided for in the Lacey-Zaroubin cultural agreement of 1958. Section 14 of this pact authorizes the exchange of civil air rights with details to be negotiated at the convenience of both governments.

Aeroflot operations experts predicted that they could make the Moscow-New York flight nonstop, even in the face of the prevailing westerly winds, in from 10 to 12 hr. with a 120-passenger load. They predicted that with a cruising speed of 450 mph. on the nonstop operation they could beat the block speed time of a Boeing 707 or Douglas DC-8 making one stop between Moscow and New York. They also indicated Aeroflot would seek rights to use the polar route to New York on its nonstop service. Other tentative plans call for establishment of an Aeroflot maintenance base in London as an alternate service point for the route.

In early June, just before leaving for the Paris air show, the Tu-114 completed what was generally regarded as one of its final proving flights carrying a load of 170 Soviet government officials, aircraft industry technicians and Aeroflot employes on a 4,600 mi. nonstop flight from Moscow to Khabarovsk in 8 hr. 45 min. with the prevailing westerly winds for an average ground speed of 515 mph.

The extreme confidence displayed by the Aeroflot operations people with the Tu-114 and its 12,000 eshp. turboprop engines with two sets of four-bladed contra-rotating propellers after more than a year of test operations, plus the three-year military experience with similar equipment on the Bear bomber, leaves western observers extremely puzzled. This comes in the face of persistent U.S. military, engine and propeller experts' opinions that the propeller problems, in absorbing such high gas turbine powers, are insurmountable and similar programs have consequently been abandoned in the United States.

Aeroflot has received a clear mandate in the Seven Year Plan that began last January as to its task in developing its jet fleet and international route expansion. From the 33% of its traffic that jet equipment is scheduled to haul by the end of 1959, Aeroflot has been given a goal of 95% jet operations by 1965. Its passenger traffic quota is scheduled to jump from 9 million in 1958 to 15 million this year and 21 million in 1960, and by 1965 it is supposed to equal the 45 million mark set by U.S. airlines last year.

Along with this expansion directive, Aeroflot has received a clear policy decision that it is to be the primary mode of passenger transportation in the Soviet Union and it is to develop both a capacity and fare policy aimed at achieving that end.

IL-18 turboprop transport in flight during its exhibition at the Paris air show.

Aeroflot's fare structure is difficult to analyze in terms of foreign currency since there is such a wide variety of exchange rates, ranging from the official 4 rubles to one dollar through the tourist rate of 10 to 1 and the black market rate now ranging as high as 30 to 1. Aeroflot's political directive to achieve the lowest possible domestic fare structure also is tempered by its requirement to operate according to the Soviet standards of producing a profit.

Both the political directives and the high density seating equipment such as the Tu-104B, the Tu-114, the Il-18 and An-10 are pushing Aeroflot into the high traffic volume-low fare philosophy that is finding increasingly sympathetic ears in England and the United States. In its international fare structure, Aeroflot officials say they will adhere strictly to International Air Transport Assn. rates, even though they are not members of IATA nor give any indication they plan to join.

There already is a two-class fare structure for domestic Aeroflot fares with about a 15% reduction for tourist service below the first-class rate. Although this differential now is aimed primarily at offering slower piston powered air travel at a lower rate than jet speeds, there also are tourist services with jet equipment. With the appearance of the extremely high density Tu-114 and An-10A on passenger service, Aeroflot officials predict that domestic fares will go still lower and become cheaper than the ordinary rail fares.

Aeroflot is already highly competitive with the railroads for domestic traffic. A good example is the Moscow-Leningrad service, roughly equivalent to the New York-Chicago run in terms of linking the two largest cities of the country over about the same distance.

Since Aeroflot began its 55 min. Moscow-Leningrad flights with the Tu-104B this spring it has been generating traffic on this route at an amazing pace. The service now is up to four round-trip flights daily with passenger demand so heavy that the 100% load factors of the scheduled flights are frequently supplemented by extra section flights in Tu-104As and Il-18s which also run over 90% full.

The competing train service with the best equipment in the USSR takes 12 hr. against the Tu-104B's 55 min. The rail fare is 150 rubles against 130 rubles for an airline ticket.

Aeroflot's Size

Aeroflot is the world's largest airline by any of the measurable standards that are available on its operations. It flies over 350,000 route miles and serves 129 major airports, plus some 329 cities without improved airport facilities. In addition to its operational jet fleet of nearly 200 transports, it has some 1,600 twin piston engine transports and uncounted hundreds of single engine feederliners, helicopters, ambulance planes and crop dusters.

It also has responsibility for building and operating all civil airports, installing and maintaining airways communications systems, landing aids and traffic control equipment. During 1958, Aeroflot flew about 9 million passengers and at its busiest airport, Moscow's Vnukovo terminal, passenger flow reached 1,000 an hour during peak periods.

The biggest western airlines in comparable categories are Air France with 173,000 route miles, American Airlines with 7 million passengers carried in 1958, and the combined fleet of the U.S. flag trunkline airlines with 137 gas turbine transports and 1,100 four engine and twin engine piston powered transports.

AEROFLOT TU-114 is parked at New York International Airport after flying nonstop from Moscow to New York with the Russian delegation to the Soviet science and industrial exhibit. The 370,000 lb. turboprop transport made the 5,092 mi. trip in 11 hr. 6 min.

Tu-114 Flies Moscow-New York in 11 Hr.

By Erwin J. Bulban

New York—Aeroflot's 370,000-lb. four-engine turboprop Tu-114 will go into service on long-range routes serving Russia and its satellites in three months, designer Andrei Tupolev said following his arrival in New York after a 5,092-mi. nonstop flight from Moscow which brought Frol Kozlov, first vice chairman of the USSR council of ministers, his staff and top Aeroflot personnel to open the Soviet science and technical exhibition in this city.

The Tu-114 is in "series production," and approximately 12 or 15 of these airplanes are ready for service, Tupolev reported. He said that it is the most economical airplane in service today—an Aeroflot official told AVIATION WEEK that the Tu-114 costs less to operate than the Bristol Britannia, and pointing to a 1049 Super Constellation parked nearby, said the Soviet airplane also costs less to fly than the Lockheed aircraft.

Tupolev said the Tu-114 was specifically designed for low operating costs, noting that the Soviet government has been extremely cost-conscious concerning this project.

Tupolev emphasized his belief that the future of air transportation belongs to the big airplane. He noted that on the Moscow-Peking route, one Tu-114 can handle the same workload as 14-16 crack express trains. (See p. 34.)

The 70-yr.-old Soviet aircraft designer revealed few new technical details concerning the big turboprop—but did mention that overhaul time for the 12,000-shp. turboprop engines currently is 250 hr.

Anti-Noise Program

New York—The Port of New York Authority says it is pleased by the program of anti-noise procedures for jet and piston aircraft recently announced by the National Air Transport Coordinating Committee (AW June 29, p. 29).

Monitoring of jet flights will be continued by the Port Authority, however, and violations of the agency's perceived noise decibel limits over communities will be reported to airlines as in the past, if and when they occur.

The Port Authority said "We are pleased to know that this continuing effort on our part has finally resulted in the recognition by all airlines and other segments of the aviation industry that the Port Authority's insistence upon the use of runways leading away from communities whenever possible is necessary to achieve tolerable operation."

The airplane, CCCP-L5611, which brought the group to New York, has 300 hr. flying time, according to a Tu-114 crew member.

The airplane made the flight to New York in 11 hr. 6 min. at an average speed of 460 mph., going via Riga, Stockholm, Oslo, Bergen, Keflavik, Gander, Boston. In 1958 AVIATION WEEK reported that the Tu-114 would make the Moscow-New York run in 10-12 hr. (Aw Feb. 17, 1958, p. 38).

Solid Overcast

The navigator reported that the Moscow-Bergen segment was made over broken cloud; from Bergen to New York there was practically solid overcast, the airplane flying between cloud layers. Most of the flight was made at 33,000 ft. Navigation was primarily by terrain-mapping radar, high-frequency radio and radio compass. The airplane was in contact with Moscow constantly up to arrival in the New York area. The airplane is equipped with Loran gear, but this was not used because Russian equipment operates on frequencies different from Western equipment. Approach at Idlewild International Airport was made using Ground Controlled Approach radar, ceiling being some 400-500 ft., visibility two miles and considerable haze. First landing attempt

aborted, the pilot peeling off sharply as he made a go-around, due to excessive speed on approach, according to one of the three U.S. crew members aboard the flight.

On second letdown, the airplane seemed excessively high to some ground observers as it broke through headed for Runway 22, but the airplane touched down and completed a successful landing with room to spare, although use of considerable brake was noticeable. It appeared that the Tu-114 should be capable of operating from the same runways as piston airliners.

USAF Pilot Aboard

Two crews of four men each—captain, pilot, radioman and navigator—were used, each flying approximately three hours at a stretch. USAF pilot Maj. Augustine Puchrik, who took turns flying the airplane, reported to AVIATION WEEK that he was very impressed with its features and handling characteristics. He pointed out that the autopilot, for example, which incorporates all the features of modern U.S. equipment, "really works—better than some I've flown with here," he said. Synchronization of the four sets of contra-rotating propellers is automatic, and this too, worked very well during the flight. Propeller synchronization is a hydraulic system, according to a Soviet crew member.

Use of the Tu-114 on this flight had no special significance, according to Aeroflot senior inspector Nicolai Grachev; mission requirement given the Soviet national airline was to transport Kozlov and his party to New York by the most comfortable and fastest method and this airplane met the requirement most suitably. It was obvious though that the flight did forcibly bring to the attention of the West and the U.S., with whom the Russians are attempting to negotiate a bilateral agreement, that Aeroflot has an aircraft capable of handling the service it is seeking to establish.

30-Ton Payload

The Tu-114 left Moscow with a 30-ton payload of passengers, baggage and freight and arrived in New York with sufficient reserve fuel to continue flying another four hours. Baltimore was an alternate in event New York was closed. Although the Russians declined to say what the airplane's fuel capacity is, AVIATION WEEK learned that they have ordered 65 tons of fuel to be ready for their departure. Length of stay in New York was also difficult to ascertain and probably depends upon how long Kozlov expects to remain here. There were no plans, as of late last week, to take the airplane on a demonstration tour of the U.S.

Hughes Tool, TWA Ask Board For Jet Lease Deal Extension

By L. L. Doty

Washington—Trans World Airlines and Hughes Tool Co. last week told the Civil Aeronautics Board that financial arrangements which would permit TWA to operate its Boeing 707-131s on a permanent basis have not been completed.

Meanwhile, Pan American World Airways disclosed that it has signed an agreement with Hughes Tool for the purchase of six of the 18 long-range Boeing 707-331 intercontinental turbojets Hughes has ordered. At the same time, Pan American has given Hughes an option to buy six of its Boeing 707-121s. The option expires Sept. 30.

At present, TWA is operating a fleet of 11 Boeing 707-131s under a day-by-day lease arrangement with Hughes Tool at a rental fee of $2,500 per day per airplane. The airline and Hughes Tool, which holds a 78% interest in TWA, asked the Civil Aeronautics Board for an extension until Sept. 30 of the temporary lease agreement.

Here is a breakdown of the current status of the two carriers with respect to their equipment programs:

• **Hughes Tool Co.** has placed orders, under contracts assignable to TWA, for 15 Boeing 707-131s, 18 Boeing 707-331s and 30 Convair 880s. Hughes is not committed to sell any of these aircraft to TWA, nor is TWA committed to buy any of them from Hughes.

• **Pan American has ordered** five Boeing 707-121s, 17 Boeing 707-321 intercontinental turbojets and 21 Douglas DC-8s. The carrier is purchasing airframes, powerplants and spares without any lease arrangements. However, it does have an agreement with Douglas Aircraft Co., whereby four of the DC-8s may be released to Douglas for sale to Panair do Brasil, in which Pan American holds a 48% interest.

• **TWA is operating** 11 Boeing 707-131s under the temporary lease with Hughes. One more aircraft is to be delivered under this present lease. A similar day-to-day contract will cover the delivery of three more 707-131s on order from Boeing with all leases to expire Sept. 30. The present lease calls for the sale of $3.5 million in spare parts at cost to TWA.

• **Temporary leases** between Hughes and TWA were to have expired June 30 at which time both companies had anticipated that a permanent "definitive financial arrangement" would be completed. The 90 days extension has been requested to permit further negotiations on a permanant contract covering the aircraft. Meanwhile, TWA has purchased additional spare engines directly from the manufacturer to satisfy immediate operating requirements.

TWA has signed a lease agreement with Northeast Airlines (AW June 29, p. 31) that calls for the use of a Boeing 707-131 by Northeast on its New York-Miami run beginning in September. Under the contract, Northeast will operate Boeing 707-331s leased from TWA on its winter schedules if deliveries to TWA conform to schedule.

Pan American has a short term two-year mutual leasing agreement and a long-term equipment exchange 10-year contract with National (see p. 41).

The agreement between Hughes and Pan American is subject to the consent of Boeing Airplane Co. If Hughes decides to buy the six 707-121s from Pan American before the expiration of the Sept. 30 option date, sale of airframes will be completed at original cost. Sale price of engines and spares would be based on the equipment's depreciated value.

Pan American would take over all spares relating to the six TWA Boeing 707-331s on which it will take delivery from Boeing. Delivery of the 707-121s to Hughes would be accomplished as the 707-331s are delivered by Boeing to Pan American.

Under the present schedule (AW April 13, p. 36) TWA was to have received the first of its 707-331 intercontinental turbojets in November. It had tentatively planned to place these aircraft into scheduled service on its international route early in 1960.

The Pan American-Hughes deal is not expected to effect these plans even though TWA has no intention of placing the shorter-range 707-131s on its international routes. One TWA spokesman said that the airline expects to receive the first of its 707-331s, following delivery of the first six to Pan American, in sufficient time to begin the service in January.

The contract may affect the TWA-Northeast contract only slightly. TWA may find itself with a tight equipment schedule as a result of the Pan American contract as far as the 707-331s are concerned. As a result, Northeast may not be able to start schedules with the larger 707-331 at a time which would coincide with the beginning of the busy Florida tourist service. However, Northeast will still be able to compete against National and Eastern with Boeing 707-131 schedules.

New World Record

Sparked by AC at World Congress of Flight

At the controls of her twin-engine Aero Commander 680E, aviatrix Jerrie Cobb swept over an official course at an average speed of 226.148 mph—a new record for class C-1.d aircraft. Starting from Las Vegas, she flew a 1,242.7 mile triangular course over part of California and back to Las Vegas in 5 hours, 29 minutes, 33.9 seconds.

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CAB Lawyers Attack Airline Stock Deal

By Robert H. Cook

Washington—G. T. Baker, president of National Airlines, last week was accused of selling his company's "birthright for a mess of pottage" by Civil Aeronautics Board attorneys who objected to a mutual exchange of stock between National and Pan American World Airways, contending this will result in control of National by the larger carrier.

The charge, leveled by Bureau Counsel for the Bureau of Air Operations in a recommendation to Examiner Leslie Donahue, arose from a current CAB investigation of a three-part equipment lease and stock transfer agreement between the two airlines.

As filed with the Board, the agreement calls for the mutual exchange of 400,000 shares of common stock between the carriers, plus an option by Pan American to purchase an additional 250,000 shares; the short term lease to National of Boeing 707-121 jet transports and a long term lease for two-way rental of 707s and Douglas DC-8s for the next 10 years (AW Sept. 15, p. 38). With Board approval, National entered the first half of its short term lease of Pan American jets last winter season on its New York-Miami route and will complete this phase beginning this winter.

Under investigation by the Board are details of the planned long term lease and the stock exchange. Both carriers already have made a mutual exchange of 400,000 shares, which are being held by an independent trustee approved by the CAB. Pan American's option for additional shares may be exercised by 1961.

All stock thus exchanged is being held in trust and for an eight-year period would be voted only with a majority of other stockholders should the Board approve the agreement (AW Nov. 10, p. 39).

Strong Objections

While the CAB attorneys recommended approval of both lease arrangements as in the public interest and of mutual benefit to the carriers, they voiced strong objections to Board approval of the joint stock agreement and urged that the CAB direct the airlines to sell the stock and submit plans for its disposal within 90 days.

Contending that Pan American has long sought entry into the domestic market and used its new jet aircraft as "bait" both with Northeast Airlines and National, the attorneys warned the CAB not to approve the stock transaction unless Board members are prepared to approve a merger between the two airlines at a later date. Further advising that it also is opposed to any such merger, Bureau Counsel said that Pan American and National already are involved in a "partial merger" through tentative plans to combine many operational functions and in joint use of personnel and equipment.

Reviewing "vague" and "foggy" testimony gathered from officials of the two airlines during the investigation, CAB attorneys observed that it is "less clear, at first blush, why Baker so readily gave up control of his company." The answer, they said, probably was National's poor financial condition, its "desperate search" for flight equipment to compete against Eastern Air Lines' Lockheed Electra turboprop fleet and "Baker's apparent conviction that if National can run profitably for the next few years, his pension will provide a comfortable income in his retirement."

"It is quite apparent," they continued, "that Baker, who testified to a bad memory because of his age, has forgotten his past reluctance to deal with Pan American and has been dazzled by the lure of jet age gold.

"Once the facts are clear, what Baker and Pan American have done loses its aura of jet age novelty. Rather, their arrangement is as old as the Bible. Baker has accepted immediate gain with no concern for National's future. It might be said he has sold National's birthright for a mess of pottage."

Equipment Lease

Pursuing their contention that Pan American's basic purpose in entering into the agreement with National was to gain control of a New York-Florida carrier, Board attorneys said Pan American first approached Northeast Airlines and sought to arrange an equipment lease in exchange for a block of stock, even though the smaller carrier had no equipment suitable for connecting flights or jet aircraft on order for a reciprocal lease arrangement.

Final agreement between Pan American and National differed in several aspects from original written proposals between the two airlines. The attorneys pointed out that National had requested that Pan American refrain from purchasing any stock beyond the 400,000 share mark without National's permission. At the same time, they added, Baker wanted to hold the stock exchanged between companies in trust for 10 years, as opposed to Pan American's desire for only five years and a final agreement settling on eight years.

Bureau Counsel noted this coincides with the permissible retirement date of the National president. A better solution would have been the issuance of non-voting stock, the attorneys said, but Pan American apparently would not agree to this.

Claims by the two airlines that the arrangement will prove a valuable incentive for employe cooperation were discounted by Bureau Counsel, which termed the claim as a "compulsion" by National to carry out the wishes of Pan American regardless of the effect on National.

Voting Control

"As time draws near," the attorneys said, "National officers, having no employment contracts, will be likely to cooperate with Pan American for fear of losing their jobs when Pan American gets voting control."

Requests by the two airlines that the CAB approve the agreement for eight years and then re-examine it was termed "patently unrealistic" by Bureau Counsel on grounds that such action would tie the two together so closely that they couldn't be separated without injuring National.

Plans for a "partial merger" were discussed by Pan American and National last October, the attorneys said, to provide for National's use of Pan American ramp equipment, bulk fuel storage, instrument and radio overhaul facilities, plus engineering work on National's Douglas DC-6Bs and jets to be performed by Pan American. They added that testimony gave no actual proof of this pooling plan but witnesses indicated such a plan is being considered.

Consummation of the agreement, and in particular the stock phase, is being fought by Eastern, Delta, Braniff and Northeast on general grounds of both monopoly and unfair competition. Bureau Counsel also questioned whether the CAB should permit "special circumstances" which might force Northeast back on subsidy and pointed out that Pan American and National combined would have more assets, net worth and revenues than Eastern Air Lines would have.

Competitive Routes

A further disadvantage of the agreement, attorneys noted, is that it would allow Pan American to prevent National from applying for any competitive routes in either the Caribbean or Central American areas. Even if this were not the case, the attorneys added, the CAB might be forced to reject any National route application in these areas on grounds that the carrier is subtantially owned by Pan American. As an example, Bureau Counsel cited a Na-

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tional application in the Southern Transcontinental Case and asked, "Will the CAB seriously consider awarding a route of this magnitude to National if it is controlled and substantially owned by Pan American?"

Best solution to the entire question of control would be to return the exchanged stock to the issuing company at its original price, the attorneys said.

In urging the examiner to approve the agreement, the two carriers have pointed out that it will aid their jet financing plans, allow them to save on acquiring jet aircraft to meet peak seasonal demands and help National to face heavy competition from Eastern. National went from a "bleak future" of heavy losses in 1958 to an operating profit of $3.3 million during the first quarter of 1959, Pan American noted.

Combined lease of four jets affords the two airlines the use of a $27 million investment at a price about half of this and a saving of $1.7 million a year each on interest charges, hull insurance and depreciation, the carrier said. While Pan American currently owns 25% of National's stock, and National owns only 6% of the larger carrier and exercise of the option for 250,000 shares extra would give Pan American a total holding of 35%, the airline told the examiner neither party would necessarily assume control of the other since the holdings cannot be voted independently until expiration of the eight year holding period by a trustee, while either party can sell all or some of the stock.

New Securities

In addition, Pan American pointed out that National could decrease the percentage owned by Pan American by issuing new securities to outside sources. Bureau Counsel replied that the big disadvantage with the latter choice is that National's stock is so widely held, PanAm would still hold a decisive voting bloc. The lawyers favored direct sale of the stocks by both parties as a means of a significant gain in equity. Stocks of both have nearly doubled in value since agreement was announced.

Opposition to the equipment lease plans is virtually nonexistent, with most carrier objections aimed at the stock agreement. The CAB refused to accede to carrier demands that the entire three-part agreement be rejected on grounds of excess competition and possible control when it approved the short term lease. At that time, the Board cited public interest as the keynote of its forthcoming decision and indicated that provisions to hold the stock for eight years, and to vote it independently, dispelled many of previous CAB doubts as to the problem of possible control of National by Pan American.

Electras Delivered to Four Airlines

Four more U. S. and foreign airlines have taken or soon will take delivery on Lockheed Electra transports. First flight shot of the first Western Air Lines' airplane (above) was taken during a pilot training mission. Braniff Airways (below), has begun Electra service. The KLM Royal Dutch Airlines Electra, the first Model 188C with additional wing tanks for 970 extra gallons of fuel adding 750 mi. range, was photographed during taxi trials. It was due to fly last week. First Trans-Australia Airlines Electra (bottom) is shown making its delivery flight to Melbourne. Melbourne-Sydney-Brisbane service begins this week.

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SHORTLINES

► **Allegheny Airlines** has applied to the Civil Aeronautics Board for permission to operate single plane service between Philadelphia and Toronto with Allentown, Bethlehem, Easton, Wilkes-Barre, Scranton and Buffalo as intermediate points. Nonstop service between Philadelphia and Buffalo and new routes between Toronto and a number of cities including Pittsburgh, Baltimore and Washington, D. C., are also being sought by the airline. Allegheny established a new company traffic record on June 24 when 2,386 passengers boarded the company's 62 flights.

► **American Airlines** reports it reached 20.5 million revenue passenger miles on Friday, June 19, the first time any airline has topped the 20 million mile per month mark. Boeing 707-120 load factors so far this month are above 95% and the carrier's Lockheed Electra load factor is above the 90% mark.

► **Braniff Airways** board of directors has declared a dividend of 15 cents per share on 2,948,119 outstanding common shares payable on July 17, 1959, to shareholders of record at the close of business July 9, 1959.

► **Federal Aviation Agency** will begin an extensive air traffic survey involving 750 airports in all 49 states and Hawaii beginning July 9, to obtain air traffic information for the summer portion of FAA's Traffic Forecasting Project. FAA says more than 125,000 pilots are to be interviewed in both the winter and summer surveys and will be asked such questions as what type of aircraft they are flying, where they came from or were going, altitude, speed, flight time.

► **Iraqi Airways** will inaugurate a new weekly flight to Prague, via Istanbul, proceeding on to London from Baghdad and another weekly flight from Baghdad to Basra, Kuwait, Bahrein and Karachi.

► **Military Air Transport Service** has awarded four additional airlift contracts to the Flying Tiger Line, Inc., Hawaiian Airlines, Ltd., Pan American World Airways, Inc., and United States Overseas Airlines, Inc. All four carriers will operate for MATS in the Pacific.

► **Scandinavian Airlines System** and American President Lines have announced a new air-sea agreement designed to bring savings of up to $300 on round-the-world trips. Travelers would use American President liners on the transpacific part of the trip and SAS would carry them the rest of the way.

AIRLINE OBSERVER

► **Russia is applying the advantages of fast air distribution of newspapers on a large scale. More than two million copies of Moscow newspapers are being flown by Aeroflot to Soviet cities each day. In addition, seven million copies of the same papers are printed in major provincial centers through the use of air-expressed matrices. Papers printed in capitals of other republic in the USSR also are flown to outlying cities.**

► West Coast Airlines has been ordered to provide the Civil Aeronautics Board with the studies which the airline used as a basis for its decision to buy six Fairchild F-27 turboprop transports. The Board also wants forecasts from the carrier of traffic, revenues, expenses and investment during the next 10 years for a mixed-fleet operation and an all-Douglas-DC-3 operation. Purpose of the order is to provide the Board with justification for the rising trend of the airline's subsidy requirements. The Board noted that the sharp increase in break-even need coincided with the introduction of F-27s last fall but admitted that such an increase in subsidy need during the integration of larger aircraft is not unusual. However, the Board stated "it appears" that plane-miles with the larger aircraft have not declined and that available seat miles, as a result, have increased beyond the traffic demand.

► **Flying Tiger Line is planning a sales development program keyed to a recent study which indicates that an air freight market six times as large as the volume now being handled is immediately available to air freight operators. This immediate market, according to the survey, is four billion ton-miles annually compared to the 676 million ton-miles of air freight actually flown by U. S. airlines last year.**

► Lufthansa-German Airlines has ordered Rolls-Royce Conway bypass engines to power its fleet of four Boeing 707-430 transports.

► **Bonanza Air Lines has signed an agreement for the acquisition of Apache Airlines, an intrastate carrier operating in Arizona. The agreement, which must be approved by the Civil Aeronautics Board, calls for delivery of 100% of Apache capital stock in exchange for 17,000 shares of Bonanza capital stock.**

► Hawaiian Airlines is showing strong interest in a turboprop conversion of its fleet of Convair 340 transports using Allison 501 turboprop engines (AW Jan. 19, p. 39). The carrier acquired three additional Convairs last year in sufficient time for use during the 1959 peak traffic season to bring its Convair fleet to a total of seven. Short term credit agreements arranged through the company's banks were used to cover the purchase of the aircraft. Plans for long-term financing, now being worked out, will cover future Convairs as well as the three purchased last year.

► **Airline passenger traffic in the Hawaiian Islands has increased steadily since the sharp decline last year resulting from the five-month sugar strike. During the first four months of 1959, traffic showed a 22% increase over the same period last year. As a result, Civil Aeronautics Board has issued a show cause order returning Aloha Airlines and Hawaiian Airlines to subsidy-free operations.**

► Hughes Aircraft Co. has developed a parametric amplifier that is "capable of increasing radar range as much as 100%" in airborne weather radars. The device, a diode amplifier, is particularly applicable to low noise amplification of microwave signals, according to Hughes engineers. They claim an improvement in noise figure of 3 to 8 db. over the best superheterodyne receivers.

► **United Air Lines is now handling all long-haul road trips for all major league baseball teams except the Kansas City Athletics and Los Angeles Dodgers. Some teams still use railroads for short-haul trips. The Athletics use Trans World Airlines for all their flights and the Dodgers operate their own Convair 440.**

U.S.-British Mach 3 Transport Proposed

Los Angeles—Development of a supersonic transport might well be a joint Anglo-American venture, according to Peter G. Masefield, managing director, Bristol Aircraft, Ltd. Cost of such a program may easily run $300 to $400 million, said Masefield, and government support in the form of underwriting development costs will be necessary.

Masefield offered a four-point program under which Anglo-American cooperation could be achieved, making joint development of a supersonic transport possible:

- **Cooperative development** and production program—to supply a supersonic transport by 1970.
- **Defense coordination,** a start on which has already been made.
- **Educational exchange system** which will provide a year's experience in the other country for prospective university students.
- **Engineering transfer scheme** to provide experience in manufacturing, operating or research fields permitting a British-American exchange of ideas.

Mach 3 Development

Masefield, speaking at the national summer meeting of the Institute of the Aeronautical Sciences, referred to the "supersonic 70s" as the period during which a Mach 3 airliner could be operational. Engine development was cited as one reason for the 1970 figure. He expects Bristol to gather considerable data for a Mach 3 transport from its "high-supersonic, all-steel research aircraft which will be flying shortly."

Highest utilization rate and therefore best theoretical economy could be achieved at Mach 3.85, but since this is a big jump, Mach 3.0 might be a better speed.

The interim between now and the "supersonic 70s" should be spent in improving our present generation of jet transports, said Masefield. A large number of the traveling public would be more interested in lower costs than in supersonic flight. Twenty minutes saved in ground transportation and baggage handling would effect the same time saving that increasing cruise speed from Mach 3 to Mach 5 would save on a transcontinental flight. Most promising single development for present-day jet transports is the turbofan engine, Masefield said, pointing up that the newly developed bypass engine will permit quieter ground operation, increased takeoff thrust and better specific fuel consumption.

Accord was reached regarding the speed range of a supersonic transport—Mach 3.0 to 3.5—in separate proposals by Hall Hibbard and R. A. Bailey of Lockheed Aircraft Corp. and R. R. Jamison of Bristol Siddeley Engines, Ltd. Both agreed that the aircraft is economically feasible and would be fabricated of steel.

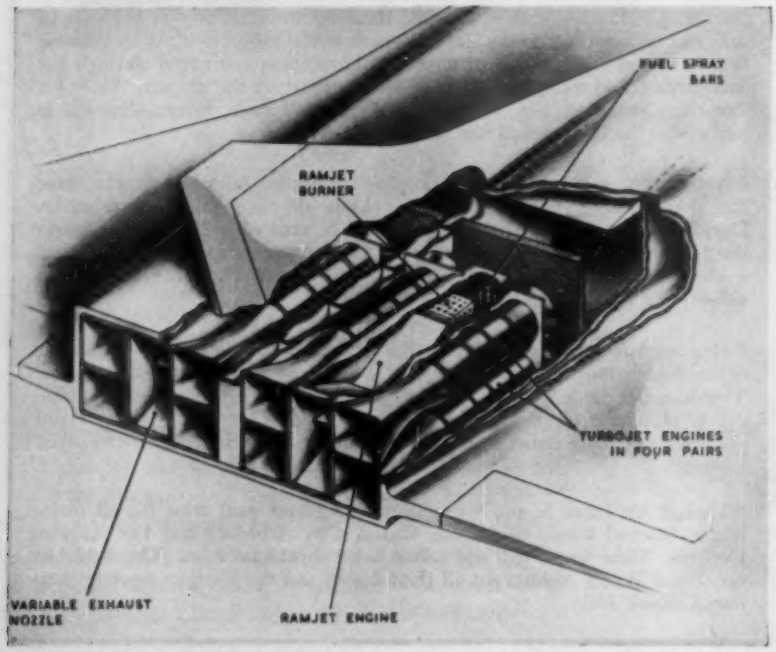
United States and British proposals differed, however, in the selection of engines; Hibbard and Bailey favored the pure turbojet and Jamison favored a combination turbojet-ramjet powerplant.

Combination engine is preferred by Jamison because of the high power required for sustaining Mach 3 flight and because specific fuel consumption of the ramjet becomes competitive with the turbojet in the Mach 3 speed regime. Ramjet portion of the combination engine would not be used for takeoff, but would be started at approximately Mach 0.8 at 20,000 ft. and continued throughout climb and cruise. Thermal stress on the turbojet compressors in sustained Mach 3 cruise could be relieved by throttling back the turbojet engines.

Jamison claimed his transport proposal would have considerable "stretch" built into it because of mating the airframe to ramjets. Incremental increases in engine thrust could be accommodated since stainless steel construction will tolerate higher aerodynamic heating loads. Takeoff gross weight of the aircraft Jamison discussed would be approximately 300,000 lb.

The case for the supersonic transport discussed by Hibbard and Bailey indi-

MODEL shows configuration of Mach 3 twin-fuselage transport with a combination turbojet-ramjet powerplant proposed by Bristol Siddeley Engines, Ltd. Sectioned view of engine bay below shows layout of the combination turbojet-ramjet powerplant's components.



cated that the aircraft would weigh "considerably less" than today's conventional subsonic jet transports. Selection of non-afterburning turbojet engines, together with stainless steel construction, warranted the estimate of a certification date in 1965, while the British proposal estimated 1970 as the operational date.

Another technical session of the Institute of Aeronautical Sciences summer meeting heard F. Gene Keyt of Minneapolis-Honeywell Regulator Co. argue in favor of electrical primary flight control systems for modern supersonic aircraft. Keyt pointed out that the advent of supersonic flight has made some degree of automatic flight control necessary and the pilot has had to relinquish some of his authority because he cannot sense and react swiftly enough. Present-day high performance aircraft use electrical automatic control systems and hydro-mechanical primary flight controls and dependency on electric systems is likely to increase rather than decrease. Therefore, said Keyt, an integrated approach to the flight control of aircraft is needed.

Advantages he claimed for an integrated electric flight control system included:

- **Less complexity** and weight.
- **Increase of flexibility** in cockpit layout and aircraft cabling as compared with mechanical systems.
- **Better dynamic performance** because of elimination of some present units.
- **Feasibility of standardizing** flight control systems.

Greatest drawback to electrical flight control systems has been their unreliability compared with that of mechanical systems. Keyt claims that the integrated electrical flight system, however, will be more reliable than the mixed system using electric automatic flight control and mechanical or hydraulic primary flight control. Keyt showed the results of a comparative study indicating that an integrated electrical flight control system could do the same job as a conventional mixed system while weighing 95 lb. less.

ICAO Faces Task of Organizing Facilities for Jet Operations

By Russell Hawkes

San Diego—Problems arising from the appearance of jet transports on the world airline scene and from decreasing financial support have been underlying most discussions held thus far during the month-long 12th session of the International Civil Aviation Organization being held in Balboa Park here. The session ends July 17.

Major developments have been:

- **Election of U. S.** Federal Aviation Administrator Elwood R. Quesada to the presidency of the assembly, along with four vice presidents from the delegations of Iceland, Nicaragua, Philippines and Afghanistan.
- **Objection to the credentials** of the Nationalist Chinese delegation by a block of seven nations headed by India.
- **Election of the delegates** of 21 nations to the ICAO council, the permanent executice body of ICAO.
- **Campaign by delegates** of Central American countries, led by Nicaragua, to change the procedure of electing members of the permanent ICAO council.
- **Arrival of a pair** of Russian observers a week after the opening of the session. They are M. Fedorin, first secretary, and Lt. Col. V. Elistratov, assistant air attache at the Washington embassy.
- **Creation by the assembly's** technical commission of a plan to hasten necessary technical improvements recommended by international regional planning meetings which are said to be lagging behind the need for them.

The assembly is the governing body of ICAO and meets periodically to draw the rules and decisions under which the council and the permanent secretariat will operate until the next session of the assembly. Major sessions at which the delegates have plenipotentiary powers occur about every three years. Minor sessions are held in the interim to review routine matters such as housekeeping budgets, etc., and delegates do not have full powers of negotiation.

When the credentials of Nationalist China were accepted by the second plenary meeting of this session, India asked to be disassociated from the action since it recognizes only Communist China. The Indian statement was immediately supported by Poland, Czechoslovakia, United Arab Republic, Indonesia, Iraq and Afghanistan.

Members of the ICAO secretariat observe that the number of delegations opposing the seating of Nationalist China is rising in each succeeding session.

Argentina's Walter Binaghi, president of the council, said that present high load factors in jet transports (over 90%) cannot be maintained when jets become more common, unless unprecedented traffic increases occur or present airliners are eliminated.

Those now operating are attractive to passengers because of their speed and comfort but they have yet to face heavy competition among themselves.

Binaghi made this comment while submitting the formal report of the council to the second plenary meeting of the assembly.

Binaghi noted that all developments in civil aviation during the past few years have been greatly influenced by the appearance of the jet transports. Many of the steps to permit safe, efficient international air navigation for the big jets have been taken collectively through technical meetings of ICAO. The provision of good facilities and organization in support of jet navigation is perhaps the biggest single task now facing ICAO.

He cited evidence that a new phase of inter-carrier cooperation is beginning in the airline industry, including air services, pools, interchange or cross-leasing of aircraft, special contracts with engine manufacturers and centralization of maintenance. This pooling of resources to cut expenditures, he attributed to growing awareness of the "economic consequences that will result, unless more efficient use is made of fleets which will soon be available.

Binaghi drew a discouraging picture of the world airline traffic situation in 1958. Traffic expansion was only 5.2% compared with the 15% annual expansion which has been the rule in recent years. He said these figures make the year look worse than it really was in many areas of the world because U. S. traffic makes up 57% of the world total and there was no gain at all in U. S. domestic operations and only a 4% gain in international traffic. But the worldwide average load factor was only 56.4% compared with 57.5% in 1956 and 59.3% in 1957. He cited a 23.2% traffic growth on the North Atlantic route resulting from the introduction of tourist fares as an indication of the increase which fare reductions could bring.

The world's scheduled airlines suffered a net operating loss of $41 million in 1957 compared with a profit of $84 million in 1956. Figures for 1958 are only preliminary but they seem to indicate there has been a further deterioration in the financial picture. Part of this Binaghi attributed to general economic declines in 1957 and 1958 but he called cost increases and a decline in load factors more direct and more important causes.

Binaghi pointed out that agreement has been reached among 14 states for the installation of a submarine cable between air traffic control centers in Newfoundland, Greenland, Iceland and the United Kingdom after two years of failure to implement recommendations for a forward scatter cable system in the North Atlantic. Contracts are now being let.

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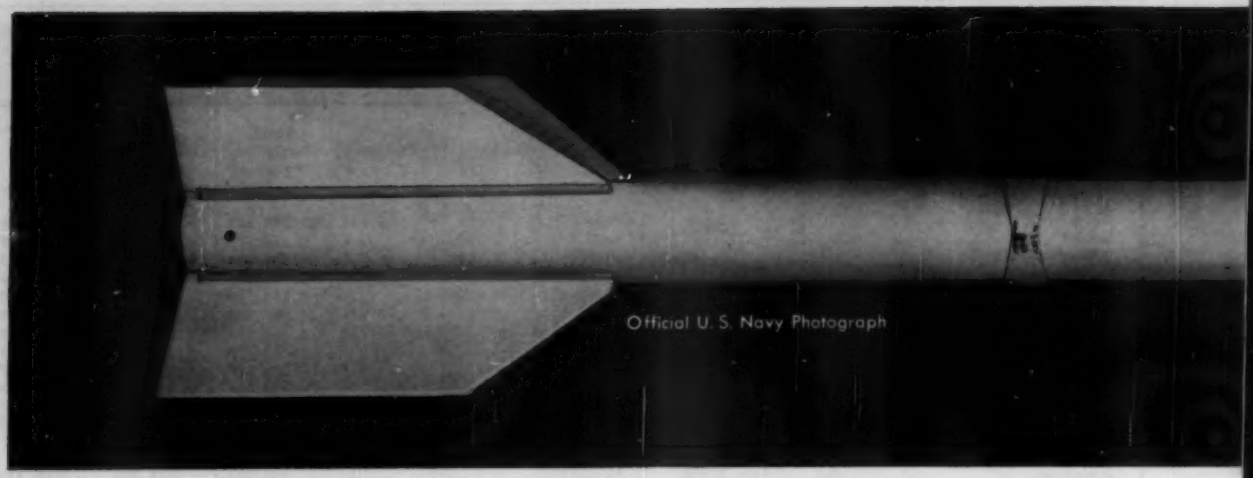
Airline Income & Expenses—April, 1959

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income (Before Taxes)
DOMESTIC TRUNK								
American	26,633,538	624,507	2,409,047†	.....	5,662	29,784,812	27,272,784	3,376,781
Braniff	4,746,225	128,493	58,019	171,133	32,910	5,232,649	4,821,402	406,427‡
Capital	9,062,546	194,822	111,690	116,494	10,365	9,635,663	9,381,950	253,713‡
Continental	9,533,000	182,000	60,000	208,000	56,000	10,484,000	10,505,000	−777,000
Delta	8,120,000	162,000	97,000	316,000	.....	8,854,000	8,069,000	737,000
Eastern	22,512,911	381,901	934,504†	.....	25,841	24,305,903	21,979,485	1,726,359
National	5,859,038	99,729	25,834	160,458	23,075	6,356,333	5,903,152	386,772
Northeast	2,642,831	38,060	19,593	40,387	.....	2,787,872	2,934,393	146,521‡
Northwest	5,827,202	177,954	537,465†	.....	7,839	6,581,727	6,705,795	124,067‡
Trans World	18,593,208	428,302	1,051,693†	.....	101,166	20,287,004	18,486,368	1,571,866
United	21,728,295	905,661	2,012,728†	.....	195,383	25,163,369	24,097,575	881,197
Western	2,707,804	88,987	38,683	97,279	18,099	4,111,674	3,906,679	545,853
INTERNATIONAL								
American	446,697	3,498	59,500†	.....	.....	535,977	615,434	−83,453
Braniff	479,724	10,222	.....	44,467	.....	581,941	553,368	−71,428‡
Caribbean Atlantic	241,715	2,363	9,835†	.....	2,840	259,406	208,097	50,344
Delta	379,000	5,000	.....	13,000	.....	412,000	443,000	−32,000
Eastern	1,949,560	23,120	79,120†	.....	40,725	2,096,316	1,885,884	182,673
Mackey	172,130	.....	500	1,461	.....	188,197	157,817	30,387‡
National	329,576	3,199	1,776	8,801	.....	352,969	306,481	47,090
Northwest	1,908,302	621,071	459,102†	.....	.....	3,100,193	2,531,143	569,049‡
Pan American								
Alaska	171,000	10,000	37,000†	.....	.....	237,000	365,000	−128,000
Atlantic	9,411,000	775,000	992,000†	.....	300,000	11,918,000	11,583,000	375,000
Latin America	5,690,000	183,000	1,015,000†	.....	55,000	7,310,000	8,436,000	−1,144,000
Pacific	4,792,000	596,000	860,000†	.....	698,000	7,251,000	6,961,000	293,000
Panagra	1,099,000	47,000	.....	171,000	.....	1,457,000	1,595,000	−130,000
Resort	.....	.....	.....	.....	646,502•	646,530	563,299	83,231‡
Trans Caribbean	244,525	.....	24,563†	.....	4,291	303,289	357,587	34,916
Trans World	3,650,049	465,467	373,756†	.....	1,112,069	5,716,894	6,617,323	−947,330
UMCA	3,575	.....	377†	.....	.....	3,974	12,936	−8,962
United	1,038,529	46,001	27,850†	.....	13,200	1,138,371	1,016,366	112,031
Western	267,756	7,542	.....	5,689	.....	286,776	350,863	−70,582
LOCAL SERVICE								
Allegheny	508,329	13,668	7,692	16,688	3,333•	782,059	850,363	−68,304‡
Bonanza	323,122	5,800	1,718	4,497	4,905	487,047	498,157	−22,931
Central	185,686	8,161	1,863	7,333	1,336	433,942	442,230	−8,288‡
Frontier	408,227	241,558♦	2,617	34,716	10,201	710,645	886,520	−192,598
Lake Central	215,930	5,733	8,029†	.....	3,762	379,297	354,596	24,701‡
Mohawk	669,113	8,732	6,367	9,067	18,056	878,385	886,552	−8,167‡
North Central	851,420	24,738	14,500	.....	22,961•	1,293,973	1,372,064	−87,984
Ozark	603,875	226,170♦	9,304	16,292	.....	862,465	858,958	2,114
Pacific	417,923	11,139	3,016	4,273	62,464	695,362	657,389	73,207
Piedmont	609,783	9,890	4,759	8,494	11,237•	963,727	934,841	275
Southern	277,442	8,670	3,820	7,860	5,303	501,700	481,640	18,834
Trans-Texas	318,190	9,801	5,027	13,339	15,319	610,160	603,954	2,645
West Coast	318,976	4,580	1,779	5,658	5,829	477,601	666,316	−188,714‡
HAWAIIAN								
Aloha	208,121	1,165	.....	5,116	168•	217,474	229,461	−11,987‡
Hawaiian	444,241	3,556	.....	55,581	1,336•	536,708	556,940	−34,499
CARGO LINES								
AAXICO	.....	2,366	3,417	44,084	443,709	590,767	516,695	74,072‡
Aerovias Sud Americana	.....	.....	115,451§	.....	5,727	124,565	121,646	2,919‡
Flying Tiger	.....	12,975	1,133,941†	.....	1,844,818	2,966,905	2,724,805	177,997
Riddle	.....	2,552	435,930†	.....	373,967	882,946	967,448	−144,952‡
Seaboard & Western*	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	.....	602,601	664,798	589,604	75,194‡
HELICOPTER LINES								
Chicago Helicopter	79,804	146,854♦	.....	.....	.....	228,178	183,345	39,748
Los Angeles Airways	17,710	12,252	9,123	.....	1,547•	117,092	121,445	4,354‡
New York Airways	61,338	4,831	489	2,888	.....	267,583	257,126	6,344
ALASKA LINES								
Alaska Airlines	207,664	58,937	819	40,731	138,853	625,023	609,023	12,932
Alaska Coastal	66,801	10,018	.....	5,871	3,545	135,670	160,885	−25,214‡
Cordova	8,951	9,390	.....	3,994	35,441	106,842	97,510	6,085
Ellis	46,900	4,200	.....	6,200	3,200	105,700	87,300	18,400‡
Northern Consolidated*	.....	.....	.....	.....	.....	.....	.....	.....
Pacific Northern	488,816	65,453	3,439	72,850	.....	874,245	843,825	18,402
Reeve Aleutian*	.....	.....	.....	.....	.....	.....	.....	.....
Wien Alaska	58,759	47,720	.....	27,666	133,276	393,966	410,832	−14,865‡

*Not available.
§Common carriage.
†Property figure.
•Non scheduled transportation.
‡Net operating income.
♦Includes Federal subsidy.



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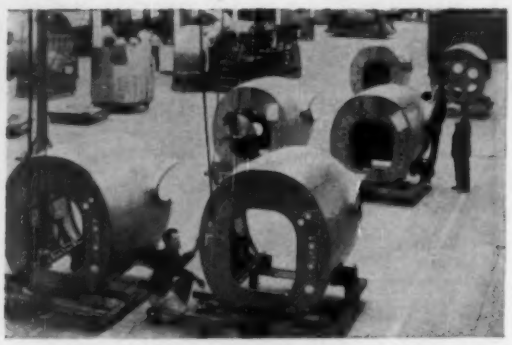

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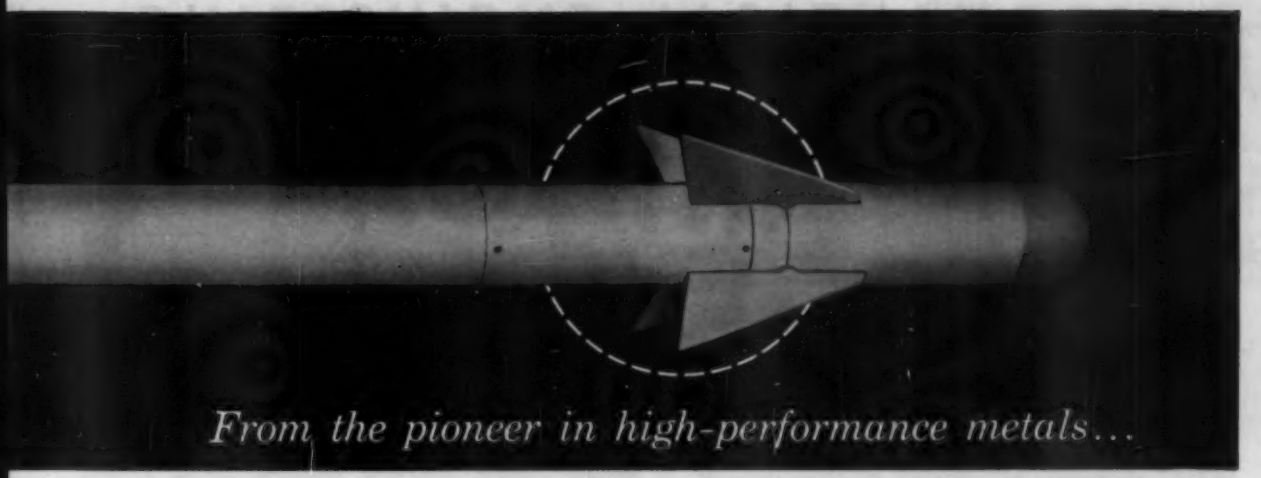

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Close-tolerance, delicately contoured fins for the Sidewinder air-to-air missile are currently being produced from Republic Type 4130 Alloy Steel by the Storms Drop Forging Company, Springfield, Massachusetts. Choice of this high-strength alloy, according to Storms, was dictated by extreme performance requirements.

Republic 4130 offers exceptionally high strength-to-weight ratios with the highest strength values. As seen at right, tensile strength in the heat-treated condition is over 230,000 psi after tempering at 400°F., with a Brinell Hardness of 460. Uniform response to heat treatment assures complete deep-hardening penetration.

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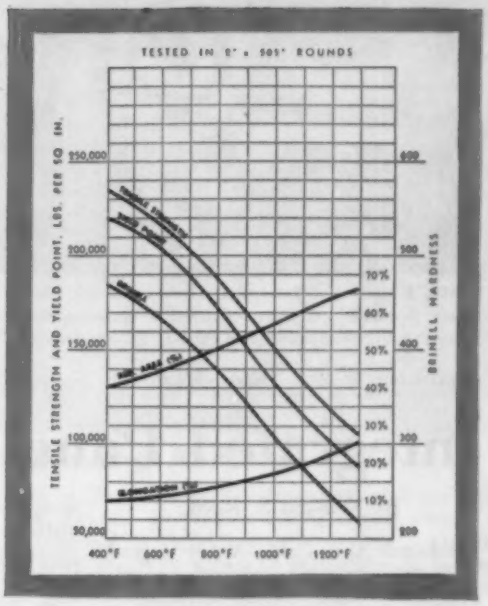

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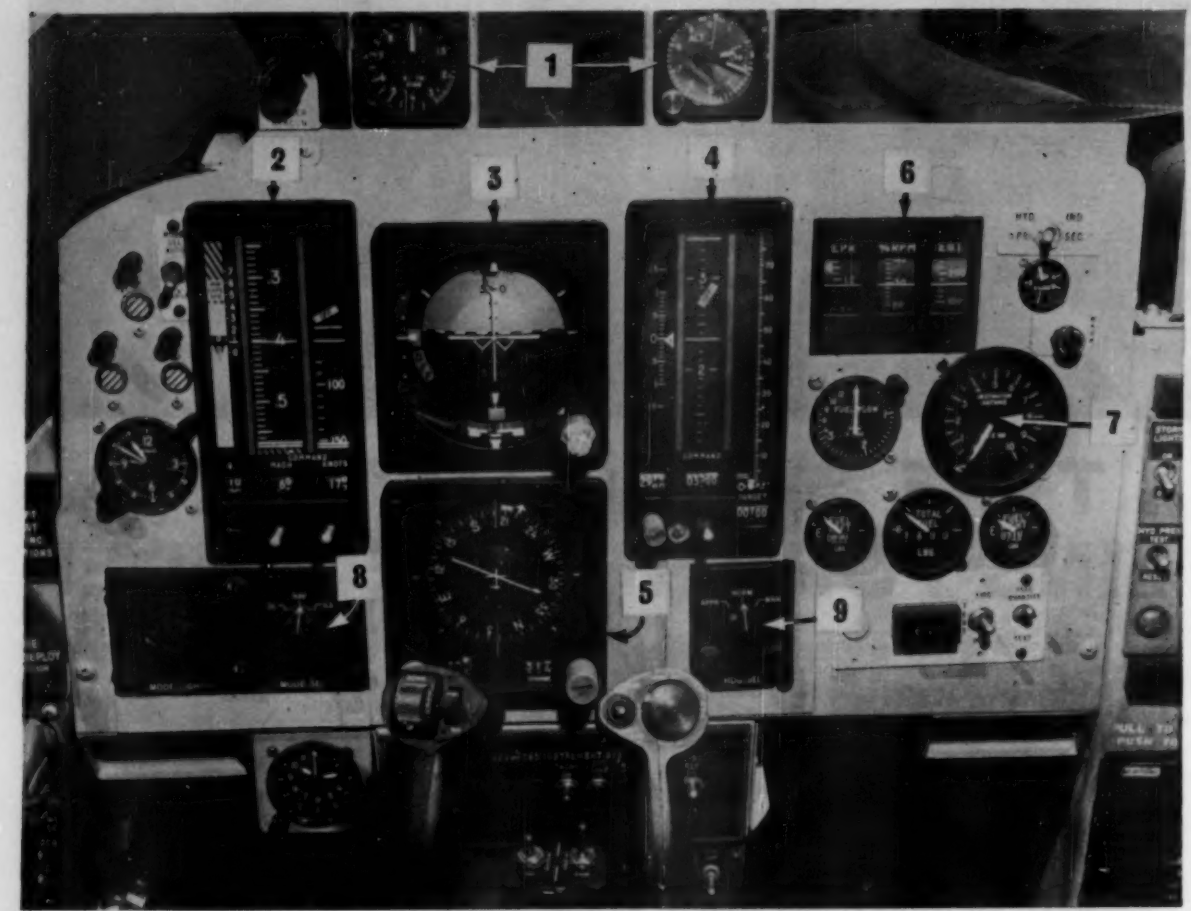

WADC'S production Integrated Flight Instrument Panel in Convair TF-102 includes: 1—standby airspeed and altimeter; 2—airspeed Mach group; 3—attitude director indicator; 4—altimeter rate of climb group; 5—horizontal situation indicator; 6—engine instruments: exhaust pressure ratio, tachometer, and exhaust gas temperature; 7—distance to destination; 8—mode selector; 9—heading selector.

Aviation Week Pilot Report:

Integrated Panel Marks Major Change

By William S. Reed

Edwards AFB, Calif.—A new "logical response" integrated instrument panel, designed to display aircraft performance to match control movements, has completed its development phases and entered production for a string of USAF supersonic aircraft. These include the Convair Mach 2 F-106 interceptor, Republic F-105 fighter-bomber and North American's Mach 3 F-108 long-range interceptor. North American's Mach 3 B-70 intercontinental bomber probably also will incorporate this innovation.

Pilots agree unanimously that there is a need for improving instrument displays, especially in high performance aircraft. The prime reason given by designers for the trend toward automaticity and pilotless vehicles is that pilots cannot perform the required tasks to the necessary accuracy. Pilots counter with claims that, given more precise, more easily read information, they can do the job, and at a lower failure rate than possible with automatic equipment.

Comments Are Encouraging

Concept of the Integrated Flight Instrument Panel is an apparent step in the right direction. However, neither the instrument panel nor the concept behind it has been bought 100% by everyone to whom it has been demonstrated. Comments have ranged from enthusiastically in favor of, to emphatically against, the panel and its concept. Favorable comments have, however, in large measure outweighed those against it.

Operation of this production type integrated instrumentation was evaluated by AVIATION WEEK in a Convair TF-102 test aircraft along with Air Force experimental test pilot Capt. James A. Lucey. A typical interceptor mission, together with basic instrument flying and low approaches, was flown.

Viewed by this observer against his background of experience in high performance aircraft with conventional instruments, the new IFIP marks the most radical change in aircraft flight information display since the first crude instruments replaced a length of string tied to a wing strut.

The panel is an essentially simple dis-

play scheme designed to effect faster pilot reaction while at the same time minimizing chances of error in response.

Century-series fighters and supersonic bombers have outstripped the performance of "clocks" used today, although clock-type instruments have been continuously refined since they were first introduced into aircraft use. Similarly, attitude and heading information instruments have been refined steadily since the design and manufacture of the first crude air-driven attitude indicator and gyro compass.

Performance parameters of early pre-World War II aircraft involved order of magnitude changes from 30 to 300 mph. and altitude measurements rarely in excess of 20,000 ft. Mechanical problems inherent in designing instruments to relay aircraft performance of this magnitude to a pilot was not too difficult to cope with. Neither, in the early days, was it probable that a pilot could misread his altimeter by 10,000 ft. or misread his airspeed, at the high end of the scale, by 100 mph. Airspeed indicators in today's high performance aircraft attempt to present linear performance from 50 to 850 kt. in the same space formerly occupied by an airspeed indicator presenting information ranging from 30 to 300 mph.

Altimeters have undergone very little change, until the drum pointer idea, with the exception of a red hash mark which appears when altitude is below 10,000 ft. Attempts to present airspeed on a logarithmic scale have resulted in poor readability above approximately 400 kt. due to scale compression and hysteresis error.

Research Consolidated

The problem of developing an entirely new concept for pilot instrument panel displays was turned over to Wright Air Development Center's Flight Control Laboratory in January, 1955 (AW July 25, 1956, p. 62). A Control Display Integration Working Group was created, representing all research and development activities in the cockpit instrument area, to provide necessary management structure and to achieve comprehensive centralized overall direction of cockpit display efforts.

Out of the need for developing instruments which would have the same parametric values as high performance aircraft arose a system engineering philosophy. Ultimate development of this system engineering philosophy is an advanced method of presenting aircraft performance information—the Integrated Flight Instrument Panel or, as service pilots call it, the WADC panel.

Early in the formulation of the concept for the integrated panel, it was obvious that no amount of regrouping or rearranging of contemporary type instruments would suffice as tools needed to cope with the ever-increasing performance of new aircraft. Instrument panels had become a confusing clutter of single purpose instruments, each designed, independently of the others, to do its own particular job.

Design philosophy of the IFIP evolved into two factors:

- **All information presented** to the pilot on his instrument panel is eventually the basis for some control action on his part.
- **Control action is consistently** taken by the pilot through identical control means (stick, rudder and throttle) throughout the whole of his mission profile.

Consideration of all other factors was secondary in the performance of the instrument panel as a subsystem to the over-all weapon. Also, the need for achieving display dynamics consistent with control actions was considered of prime importance, so that changes in performance should be reflected uniformly and in a logical manner by the instruments.

One other requisite of high performance aircraft becomes apparent when the mission profile of a high performance interceptor or fighter-bomber is considered. Translating instructions from ground controlled intercept (GCI) stations, either through voice or data link into appropriate control actions by the pilot, is a difficult task.

Voice instructions to alter airspeed or altitude or change direction must be received by the pilot, interpreted mentally by him, and then translated into the proper control movements.

Through a data link system, commands can now be fed to the aircraft

About the Author

Test and evaluation flights in the early development (Phase I) of Wright Air Development Center's Integrated Flight Instrument Panel were flown by Associate Editor William S. Reed while he was an Air Force Experimental Test Pilot.

Reed spent 16 years in the Air Force, retired with the rank of major and joined Aviation Week's staff.

His background: Graduated from U. S. Army Air Corps Flying School in 1944, flew P-51s in the Pacific during World War II. Rated senior pilot in 1953.

Following a three-year tour of duty in Europe as a jet fighter pilot, he attended the USAF Experimental Test Pilot School, Edwards AFB, Calif., and upon graduation in 1954, was assigned to WADC's Directorate of Flight and All Weather Testing, Dayton, Ohio.

In addition to P-38, P-40, P-47 and P-51 fighters of World War II, he has logged nearly 4,000 hours (1,000 jet) and has checked out in the T-33, the F-80, the F-84 series including the F-84F; the F-86 series including the F-86D and F-86H; the F-94 series, the F-100, F-102 and RAF Meteor Mk. VII. He also qualified as first pilot in the C-46, C-47, C-54, C-119, C-123 and C-131.

Reed is shown examining the WADC panel in a TF-102 prior to flight. Air Force experimental pilot Capt. J. A. Lucey is at left. Note glare on instrument faces caused by large flat plate area. Glare is not particularly prominent in flight due to specially developed coating.

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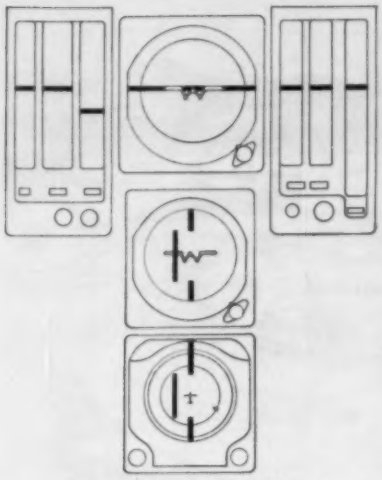
HORIZONTAL REFERENCE LINE CONCEPT



VERTICAL REFERENCE LINE CONCEPT

"T" CONCEPT of the integrated panel is illustrated. The horizontal line represents the "forward looking view," and the vertical lines represents "downward looking view."

automatically, but this sort of information is difficult to display on contemporary clock-type instruments.

For example: an increase in altitude could be indicated to the pilot automatically through data link by movement of an index around the periphery of the altimeter. This, however, would be difficult for changes in altitude greater than 1,000 ft. An alternative could be a digital readout window indicating command altitude. Objection to the digital readout would be requiring an additional mental process by the pilot in translating a digital command altitude change to the proper change on an altimeter.

Presentation of command information, consistent with logical control movement, is apparent when the integrated flight instrument panel is studied. The panel provides the pilot with both a horizontal and vertical reference line termed respectively by WADC as the "forward looking view" and the "downward looking view." Parameters in the forward looking view, along a horizontal reference line, are governed by fore and aft motions of the stick and include pitch, airspeed and/or Mach number, rate of climb, altitude, angle of attack and acceleration. "Downward looking view" parameters, along a vertical reference line, are controlled by motions of the stick sideways and include heading, bank, turn rate, navigational as well as tactical information.

Thus, by simply scanning the horizontal or vertical reference lines, it is possible to determine whether or not

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REPORT FROM ***ARMA***

The Missile Train—Mobile Sunday Punch

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For such imaginative projects as the missile train, which combines maximum mobility with maximum firepower, ARMA has developed an equally imaginative universal navigation system. Not only can ARMA systems rapidly locate and aim all types of Army missiles, but they are applicable to all types of land, sea and air operations. To the Army, ARMA offers precise vehicular navigation systems for use in artillery and missile survey, combat vehicles, tanks, and helicopters as well as remote control types for mine detection and atomic blast survey. Precision navigation systems are ARMA's business from ships to ICBM's and—beyond.

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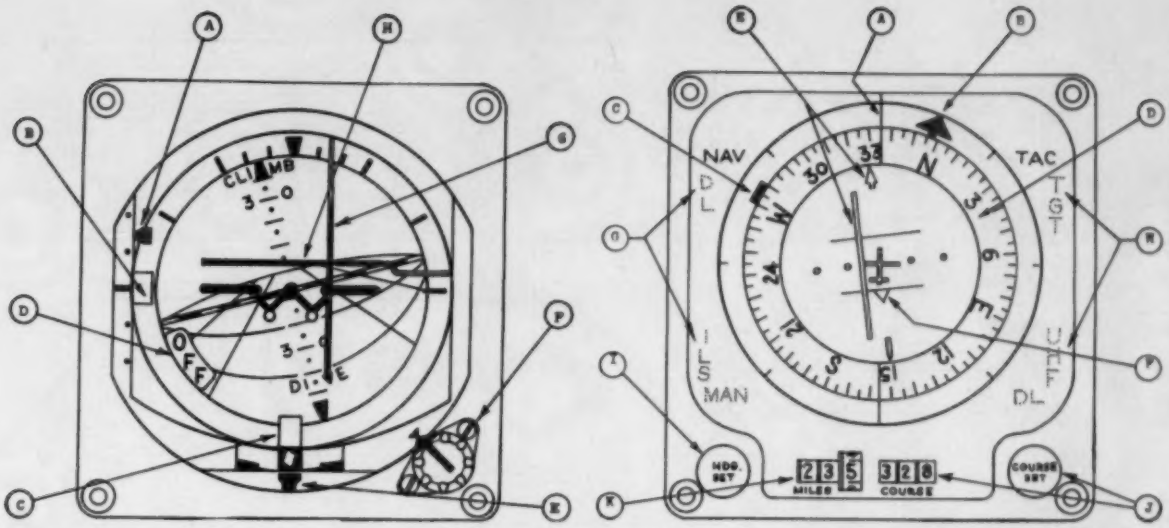


ATTITUDE director indicator (left) includes: A—glide slope displacement pointer; B—glide slope alarm flag; C—localizer alarm flag; D—power off flag; E—rate of turn needle; F—pitch trim knob; G—bank director needle; H—pitch director needle. Horizontal situation indicator (right) includes: A—aircraft heading; B—bearing pointer; C—command heading; D—compass rose; E—course arrow and deviation bar; F—to-from indicator; G—mode windows for pictorial display; H—mode windows for bearing pointer; I—manual select knob for command heading; J—course select knob and digital readout; K—digital readout for distance. Instruments are production versions.

the aircraft's performance, in relation to airspeed, altitude and course, differs from the desired performance as indicated by the command indices or the attitude and navigation information. Concept takes the form of a "T."

In the center of the display, occupying the most prominent position because of its importance, is the attitude director which displays:

• **Completely unrestricted** attitude information in both pitch and roll based on the "moving horizon—fixed aircraft" presentation. This type of presentation was selected over the "moving aircraft—fixed horizon" type because it is believed the transition from instrument to VFR conditions or vice versa is easier with this presentation. Ball also contains pitch reference marks. Degree of freedom of the ball is restricted only by the gyro platform.

• **Glide slope displacement** is at the left of the attitude director case. A moving pointer of the "fly-to" type indicates the direction of the glide slope.

• **Turn and slip indicator** is located at the bottom of the case and is composed of the conventional steel ball in a glass race filled with fluid and a d.c.-operated precession-type turn needle.

• **Pitch and direction information** is also contained as a part of the attitude director and consists of horizontal and vertical needles. These function in a manner similar to a "zero reader" but move out of view when not in use. Vertical director needle is used for maintaining heading during instrument takeoffs, omnirange navigation, ILAS or GCA. Horizontal or pitch director needle can be used during maneuvers as low altitude bombing system delivery and ILAS (instrument landing approach system).

Mach-airspeed indicator group is located to the left of the attitude director with index markers positioned to form a straight line with the horizon reference line. Display shows:

• **Angle of attack** information, not displayed in degrees but containing a zero line, and an inverted triangle. Apex of the triangle is calibrated to indicate best approach speed. The base indicates flareout speed. Most useful feature of an angle of attack indicator is that final approach will always be at a constant angle of attack regardless of aircraft gross weight. Calculating approach speed for various gross weights is therefore unnecessary since, if angle of attack is held constant, airspeed must increase as aircraft gross weight increases.

• **Vertical acceleration** on a moving tape with a digital readout of g force appearing in a window below. Quick reference to the g indicator will apprise a pilot of the amount of maneuvering load factor left before aircraft structural limits are reached.

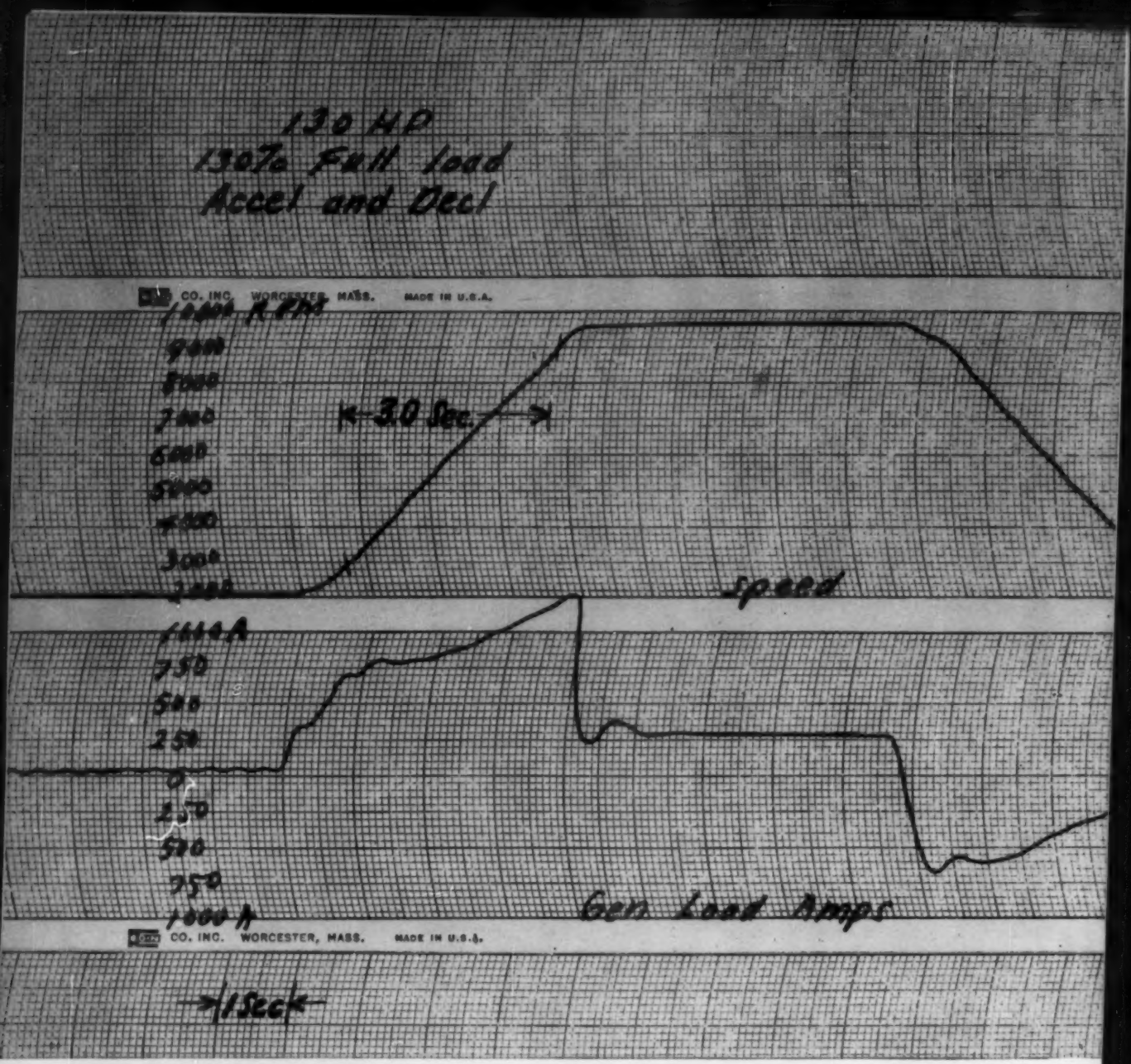
• **Moving-tape Mach meter** with a movable indicator to show command number. Function of the command index is to indicate desired Mach number to the pilot. If the aircraft were cruising at .85 and commanded Mach number was 1.5, the index would move down the tape denoting forward movement of the stick or throttle for increased speed. Indications for slower speed appear as the reverse, indicating a backward movement of the stick or throttle. Digital readout of command Mach number appears in the window below the Mach tape.

• **Airspeed tape** is closest to the attitude director and has a moving index similar to that on the Mach tape. Digital readout window also is used for command airspeed value. Slewing switches for both Mach number and airspeed permit the pilot to select predetermined values of these parameters.

To the right of the attitude director is the altimeter, rate of climb group, displaying information relative to the aircraft's altitude and related trends.

• **Rate of climb indicator** does not feature a moving tape. For the sake of uniformity of display, the scale on the rate of climb indicator is fixed but the pointer moves, thereby giving an indication of vertical speed. Were the tape to move rather than the indicator, there would be no apparent break in the uniformity of the horizontal line and changes in vertical speed would not be so readily apparent. Scale of rate of climb indicator is from zero to ±2,000 fpm. Vertical speed in excess of this amount, up to 40,000 fpm., is indicated by vertical moving tapes at top and bottom of instrument actuated when the index marker reaches the extreme top or bottom of the scale.

• **Altimeter is located** in the center of the right hand group, the tape moving downward as altitude increases. Increase or decrease in altitude is expressed in a rather natural manner, similar to that of a passenger in an elevator as ascending or descending past various floors in a tall building. Command index for the altimeter can be



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One of two control consoles of the North American Aviation, Columbus, alternator stand showing one main drive motor and speed increaser with incoming switchgear and motor control centers in background.

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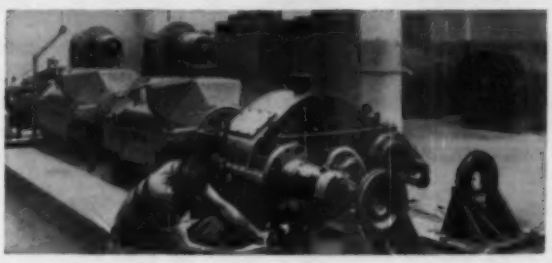
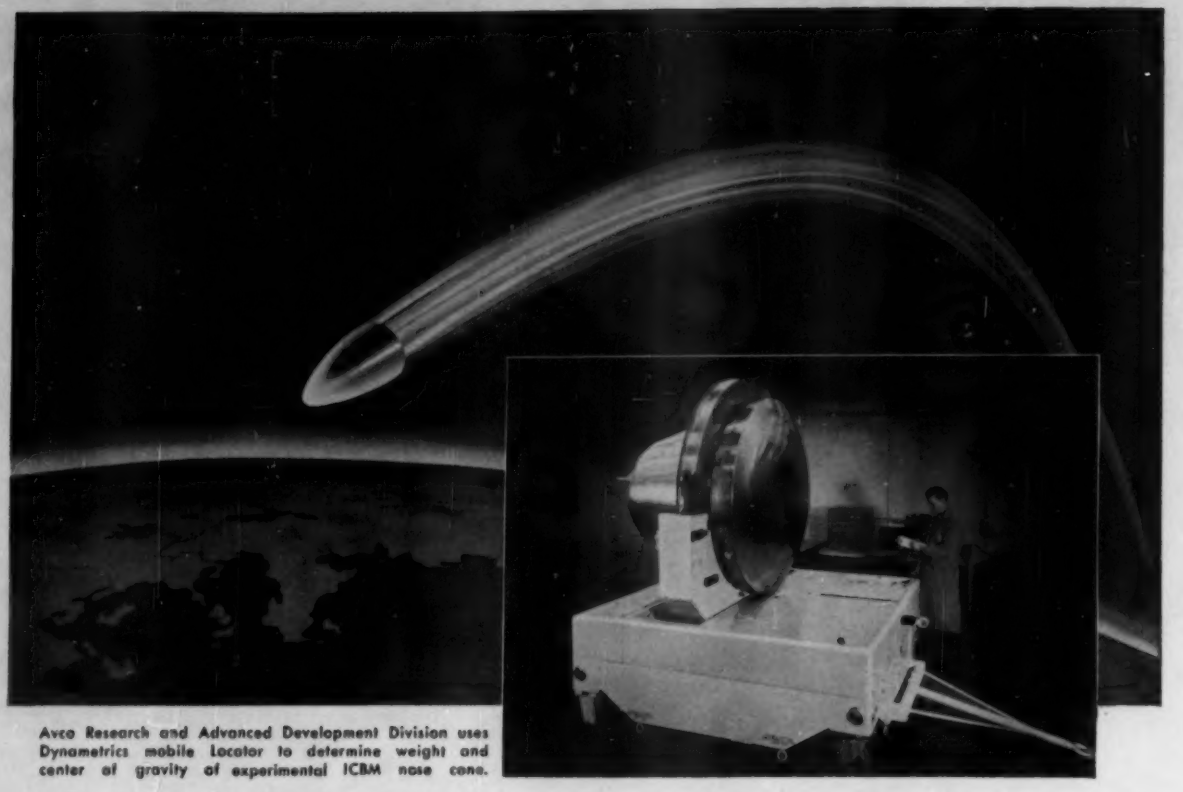


Complete dual end d-c drive showing two of four AND pads with aircraft alternator being prepared for testing. Main motor generator sets and dual test-drive control in background. J-92007



Avco Research and Advanced Development Division uses Dynametrics mobile Locator to determine weight and center of gravity of experimental ICBM nose cone.

PUTTING THE BUSINESS END . . . IN BUSINESS

The nose cone or "business end" of an ICBM will disintegrate from the violent shock and 15,000°F temperature that builds up as it plunges back into the dense air surrounding the earth's surface, unless re-entry can be made at the optimum attitude.

Dynametrics has developed a Weight and Center of Gravity Locator for precise determination of weight of the nose cone and CG components along its 3 principal axes as part of the procedure for insuring that the nose cone will be aligned properly as it re-enters the atmosphere. Avco Research and Advanced Development Division, developers of re-entry vehicles for the Air Force Titan and Minuteman ICBM's, are successfully using a Dynametrics Locator to put the "business end" in business.

The Dynametrics Weight and Center of Gravity Locator combines the accuracy of a laboratory static balance indicator with the ruggedness required for field usage. At the flip of a switch, this unique instrument gives easily legible digital readout of weight and center of gravity for two axes of the nose cone. Then, by rotating the cone 90°, another reading is obtained in the same manner along the third axis. Measurements are independent of gravity variations since the instrument operates on the principle of gravity moment balance rather than spring deflection.

Capacity of the Locator is more than 4,000 lbs. with an indicator resolution of tenths of pounds. The Locator is mobile by air transport and is adaptable to quick field setup. This instrument can be used by untrained personnel — a most significant feature with reference to the operational phase of missile work.

The Weight and Center of Gravity Locator is a typical example of Dynametrics' capabilities in solving difficult force and pressure measurement problems. Write for technical information about any one of the Dynametrics' three areas of interest: *Special Services and Equipment* such as Wind Tunnel design, CG Locators, Strain Gage Balances, and Missile and Aircraft Models: *Weighing, Proportioning, and Batching Systems; Pressure Measuring Instruments* such as Manometers, Primary Presure Standards, Digital Barometers, etc.

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set for any preselected altitude and also appears on a digital readout window below the altimeter tape. If commanded altitude is above or below the actual altitude of the airplane, it will be displayed as a displacement of the command index. Therefore, a glance at the horizontal reference line of the panel will instantly show any displacement of the command index. If commanded altitude is higher than actual altitude, the index will be above the horizontal reference line, indicating a natural movement to pull back on the stick to align indices. A slewing switch is below the digital readout windows for preselecting command altitude.

• **Planning altimeter,** on a compressed scale from zero to 80,000 ft., is located to the far right of the altitude group. Planning altimeter shows an over-all picture of aircraft altitude, command altitude, target altitude and, by means of a hashed index, cabin altitude.

Immediately below the attitude indicator is the horizontal situation indicator which presents navigation and tactical information. Following through with the vertical reference line concept, this instrument displays:

• **Aircraft heading,** appearing under a lubberline above a moving compass card indicator.

• **Arrow-type bearing pointer** indicating bearing of the station selected or, through data link, bearing of a target aircraft.

• **Command heading marker** which shows the heading to which the aircraft should be turned.

• **Course arrow** which can be set to the course to be flown and a deviation bar which indicates the relationship of the desired course to aircraft position. Located in the center of the display is a "to-from" arrow indication.

• **Two digital readouts** are on the lower portion of the display, one displaying miles to or from the station, the other displaying the course selected by use of the course selection knob.

Airspeed and altitude group instruments are electrically driven. Temperature and pressure probes feed into an air data computer which in turn sends signals to an air data converter which drives the instruments.

Attitude director and horizontal situation indicators are driven by a gyro reference package and flight director computer.

Angle of attack information, initially sensed from an external probe, is fed to the tape by a compensator.

Command markers are driven by a coupler unit which receives both ground radio and/or data link signals.

Flight Evaluation

Flight evaluation of the integrated flight panel has been going on since October, 1956. During this time, more than 400 hr. have been accumulated in a T-33 and approximately 300 hr. in two F-102s. More than 50 pilots representing the Air Force, Navy, Royal Air Force, Army and civilian test pilots participated in the program.

Transition time from a standard panel to the advanced instrument panel varies according to pilot experience, usually taking longer with more experienced pilots, less with the inexperienced men. At no time, however, is the transition time considered excessive or beyond the average pilot's capability.

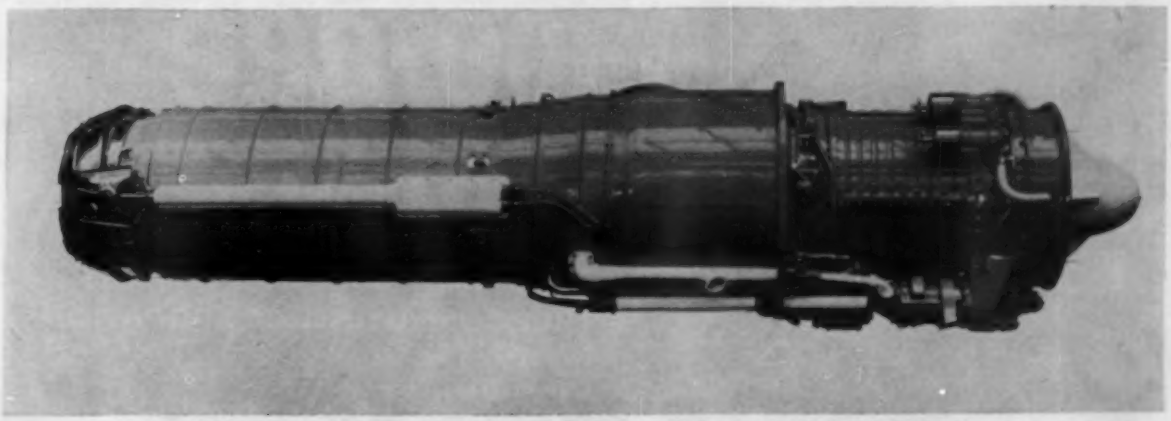
AVIATION WEEK's experience with the integrated-panel fitted TF-102 showed this sequential performance in a simulated intercept mission:

• **Aircraft was taxied** into position, lined up with the runway and the throttle advanced to military power. Airspeed command index was set at 120 kt. by use of the slewing switch and reference to the airspeed digital readout. Heading select knob was set at the manual position, the vertical steering needle centered by use of the course knob. Airspeed of 120 kt. was selected as nosewheel liftoff speed, deemed advisable due to strong, gusty surface winds.

• **Brakes were released,** and while heading was maintained with nosewheel steering engaged, afterburner was cut in. Aircraft soon accelerated to where command index was aligned with the horizontal reference line and nosewheel was lifted off. Direction and attitude information was at all times easily available by reference to the Attitude-Director Indicator. It was obvious, following through with this simulated instrument takeoff, that very little cross-checking was necessary to keep a constant heading and to maintain a positive rate of climb while accelerating to the best climb airspeed. Command airspeed was reset at 300 kt. and command altitude set at 5,000 ft. at which point turnaway from the field was executed.

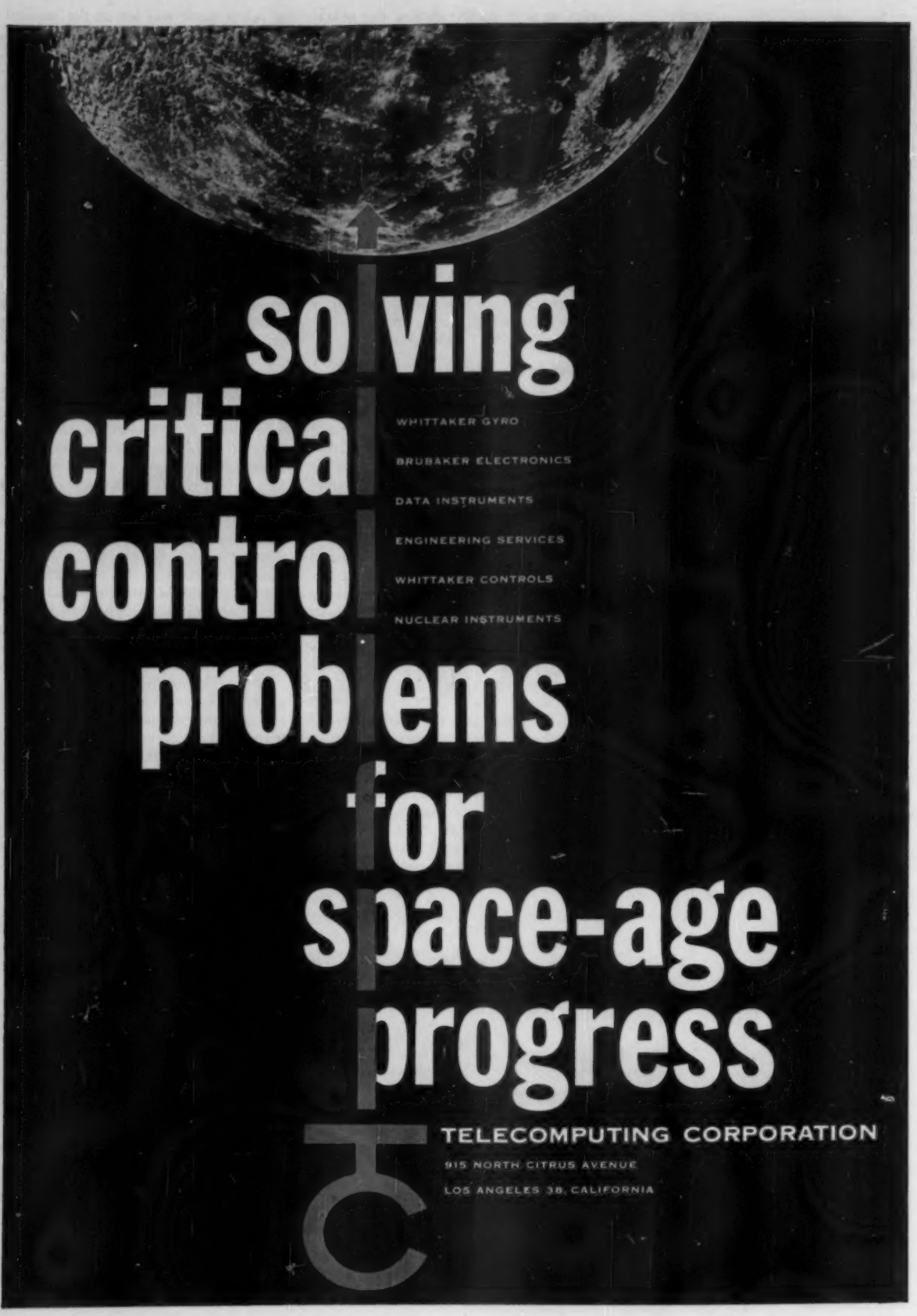
• **Aircraft was allowed** to start acceleration to best climb Mach number which had been set into the Mach meter prior to takeoff. A maximum of 350 kt. was maintained until the best climb Mach number coincided with the index. At this point, attention was shifted to holding a constant Mach climb by aligning the command index with the horizontal reference line. Aircraft was leveled off at about 15,000 ft., throttled back to 300 kt. indicated airspeed.

Although additional effort was required to set in Mach number, airspeed and altitude commands, it was apparent, despite a long absence from flying, that maintaining proper climb schedule and leveling off at predetermined altitudes was accomplished much easier than with conventional instruments. Optimum, of course, for the interceptor misssion will be for the information to be preprogramed to the index mark-



Orpheus B.Or. 12 Scheduled for Year-End Flight Test

Bristol Siddeley Orpheus B.Or. 12 turbojet engine develops 6,810 lb. thrust dry and 8,170 lb. thrust with afterburner and variable-area nozzle shown. The engine weighs 1,110 lb. Bristol Siddeley is developing the engine under the auspices of the Mutual Weapons Development Program. It will be type-tested by the end of 1959 and production deliveries are scheduled for 1960.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ers or transmitted through data link from GCI stations.

Basic instrument work, consisting of turns to a predetermined heading, airspeed reductions and increases, climbs and descents at constant airspeed, was performed. Despite the TF-102's somewhat sensitive response to control pressures, especially longitudinally, it was possible to maintain these factors with comparative ease. Any time the altitude, heading or airspeed deviated from the prescribed values, the instruments indicated the natural direction that stick or throttle should be moved in order to effect correction.

For example, were airspeed to become too low in a turn, the command index would appear below the horizontal reference line, indicating forward movement on the stick or increase in throttle position. Similarly, when altitude deviated, both altimeter and rate of climb indices indicated the direction in which the stick should be moved.

For purposes of demonstration, the TF-102 contains a preprogramer which can be switched on to simulate data link commands from a GCI station. While at 15,000 ft., cruising at 300 kt., this preprogramer was switched on to simulate ground commands.

• **Mach index immediately showed** a command to increase to best climb Mach number, altimeter command was driven to 30,000 ft., target altitude was shown as 31,000 ft., target heading 180 deg., while interception command heading was shown to be 230 deg. Necessary control movements shown by the instruments involved advancing throttle to afterburner, accelerating to best climb Mach number, and following the steering needle information until a rollout on a heading of 230 deg. was executed. All that remained was to follow commands until visual or radar contact was made but, because of time limitations, the interception program was not completed. It was decided rather, that the time would be better spent investigating ILS and GCA landings so Palmdale omni was tuned and a let-down commenced.

• **Heading selector** was switched to the normal mode, command airspeed set at 300 kt., while command altitude was set at 5,000 ft.

• **Variations in airspeed** during letdown were immediately detectable if the command index moved from the horizontal reference line.

• **Vertical reference line** showed immediately any deviation from a direct line to Palmdale omni.

• **Rate of climb** information, instead of being pegged at 6,000 fpm. descent, as in a standard instrument, was shown in its true value, giving an indication of how rapidly the level-out altitude was being approached.

Once the Palmdale omni station was crossed, an outbound heading of 040 deg. was established. After approximately one minute, the ILS procedure turn was commenced and the heading selector mode switched to "approach" position. The horizontal situation indicator (HSI) immediately showed:

• **Displacement of glide path** from aircraft's present position.

• **Steering needle** indicating the correct direction in which to turn for glide path interception.

As the aircraft was rolled out onto the runway heading of 220 deg., it was readily apparent that the steering needle was to be given a severe test because of a strong cross wind. At the time of the approaches to Palmdale airport, wind was from 290 deg. at 40 kt., gusting to 55 kt., presenting a nearly 90 deg. strong cross-wind condition.

By the time the outer marker was reached, the steering needle had given many corrections as the wind blew the aircraft to the left of course. Ultimately, by constantly centering the steering needle, drift had been "killed" with about 15 deg. crab angle.

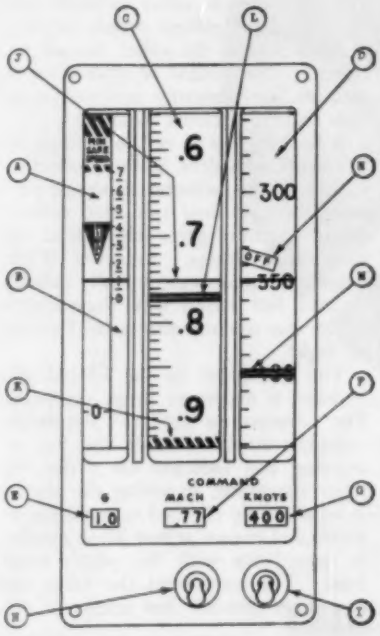
Ability of the steering needle to "kill" drift lies in its zero reader-like functioning.

When the aircraft is turning to a heading, 35 deg. of bank are required to center the needle. As the aircraft approaches to within 20 deg. of the command heading, a gradual rollout is required to keep the needle centered. Thus each time the wind drifted the aircraft to left of course, the steering needle indicated a slight bank to the right.

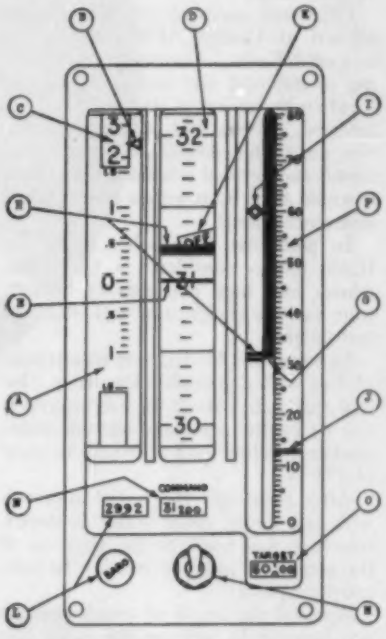
Almost subconsciously, while keeping the steering needle centered, a 15 deg. drift correction was added to maintain the glide path.

Capt. Lucey disagreed with AVIATION WEEK that a 35 deg. bank is too great for jet fighter instrument flight, but stated that the angle of bank can be calibrated to any degree should 35 deg. prove too great for widespread use.

Airspeed command index which had been set at 200 kt., before the ILS pattern, was reduced to 170 kt. at the time the glide slope was intersected. Again, keeping the instruments lined up on both the horizontal and vertical reference plane was all that was required to make a satisfactory instrument landing approach. Command values again



AIRSPEED Mach group includes: A—angle of attack tape; B—g (normal acceleration) tape; C—Mach tape; D—airspeed tape; E—digital readout for actual g; F—digital readout for command Mach; G—digital readout for command airspeed; H—command Mach slewing switch; I—command airspeed slewing switch; J—horizontal reference line; K—maximum safe Mach index; L—command Mach index; M—command airspeed index; N—power off flag.



ALTIMETER rate of climb group includes: A—rate of climb fixed scale; B—rate of climb pointer; C—rate of climb drums; D—altitude tape; E—horizontal reference line; F—vertical planniag scale; G—actual altitude; H—command altitude indices; I—target altitude index; J—cabin altitude index; K—power off flag; L—barometric set and digital readout; M—command altitude slewing switch; N—command attitude digital readout; O—target altitude digital readout.

F-102A Flight-Tests J85 Turbojet

Pod below Convair F-102A interceptor houses a General Electric J85 turbojet engine (AW Mar. 2, p. 77), being flight-tested at Edwards AFB, Calif. Engine is in 2,000 lb. thrust class.

were put into the instruments through the use of the slewing switches, but could have been given to the instruments by ground command sources.

Because of the lack of ambiguity in the display and the logical manner in which both the horizontal and vertical situations were displayed, at no time was there any doubt as to the aircraft's desired performance, actual performance or position in relation to the glide path or glide slope.

GCA low approach was also accomplished at George AFB with similar lack of difficulty. Constant cross-checking of different size and shape instruments with respect to altitude, heading, airspeed, attitude and steering information was far less difficult, using the horizontal and vertical reference lines, than it would have been with a conventional instrument panel.

In particular, approaches using the ILAS, always considered a tricky maneuver in a high performance aircraft, were easy by comparison with standard instruments.

Landing the TF-102 was also accomplished with appreciably less strain. Initial approach altitude for Edwards AFB was set on the command altitude index marker, together with approach airspeed of 175 kt.

After turn onto the initial approach with gear down, speed brakes deployed, reference was made to the position of the command index in relation to indicated airspeed.

Apex of the angle of attack triangle was brought to bear on the index line by slowly decreasing airspeed as soon as rollout onto final was completed. Reading was then cross-referenced to airspeed, eliminating the necessity of computing aircraft gross weight and flying corrected airspeed on approach.

It would be contrary to the truth to state that the integrated panel has been accepted by all to whom it has been demonstrated. Capt. Lucey, with whom AVIATION WEEK flew in the TF-102, recalled his initial displeasure at being appointed project pilot for the demonstrations. He has been associated with the Phase I panel breadboard type in the T-33 and the Phase II panel in the F-102A.

His appraisial of the panels during Phases I and II was critical and he accepted the assignment reluctantly.

However, his reluctance has now given way to enthusiasm for the performance of the panel and its potential for future high performance aircraft. According to Lucey, Maj. Gen. J. V. Crabb termed the integrated panel a great boon to inexperienced fighter interceptor pilots in the Air Defense Command after his familiarization with the production panel in the TF-102.

Criticism Voiced

Criticism against the panel is leveled primarily at the fact that the instruments are electrically driven. Historically, pilots are distrustful of electrically driven instruments because of the failure frequency experience. Instruments on the panel have not been without growing pains, but according to Maj. L. E. Armstrong, project officer from WADC's Flight Control Laboratory, the production-type instruments in the TF-102 have performed satisfactorily without serious failure since their installation.

Another criticism stems from the fact that the altitude command index covers a width of approximately 100 ft. on the altitude tape. This makes precision flying of the order possible with the sensitive altimeter virtually impossible.

The large flat-plate glass area has also come in for considerable complaint due to reflected glare. This has been mostly eliminated by applying a non-reflecting coating to the glass.

Resistance due to the fact that the panel is electrically driven may disappear if production versions can achieve a high reliability rate. Present production configuration calls for a standby airspeed indicator and altimeter of standard type to be incorporated in the panel for emergency use.

Still another criticism directed toward the panel is the high cost of the installation. The Integrated Flight Instrument Panel costs approximately $85,000 per copy or nearly six times the cost of a standard installation.

Again, it is the question of reckoning dollars versus safety, especially where human lives are at stake. Proponents of the integrated panel are convinced that the installation is well worth the dollar cost.

Difficulty of scanning the panel is another criticism leveled at the system. Experienced pilots have long been able to tell at a glance the reading of their instruments. Mostly, this is done with reference to needle position on each of the gages. Since, in the IFIP, position of the pointer index does not move, these critics say the panel defies scanning, especially when the command indices are off scale. Advocates of the panel do not have a direct counterclaim for this but say use of the command indices is desirable at all times.

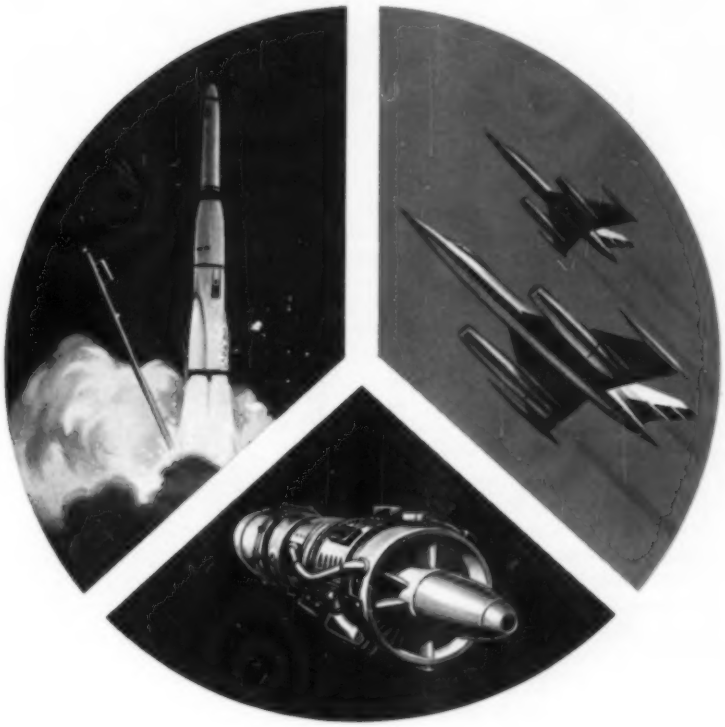
This writer is particularly impressed with the command indices as memory markers for such values as GCA and ILAS altitude, pattern speeds, heading commands and the other myriad parameters which must be committed to memory or constantly reviewed mentally and by reference to charts.

A further step in vertical-reading instruments is evident in the production panel with the inclusion of exhaust pressure ratio, per cent rpm. and exhaust gas temperature gages which read out on rotating drums. AVIATION WEEK noted that these were initially difficult to read, but accord with these instruments was reached after a brief period in flight.

The new panel on the TF-102 also includes a maximum range computer. The "destination distance" instrument considers aircraft altitude and fuel remaining and indicates on a dial the range remaining, providing the aircraft is immediately climbed to optimum altitude and cruised at best Mach number in accordance with the pilot's handbook. The instrument also takes into account a nominal fuel reserve at destination.

Production instruments for the integrated panel are manufactured by the following industry members: airspeed and altimeter groups by Eclipse-Pioneer Division of Bendix Corp., attitude-director indicator by Lear, Inc., and horizontal situation indicator by Collins Radio Corp. Vertical-reading engine instruments were developed and manufactured by the John Oster Manufacturing Co.

SPS RELIABILITY / A dynamic standard of predictable performance



THREADED FASTENERS

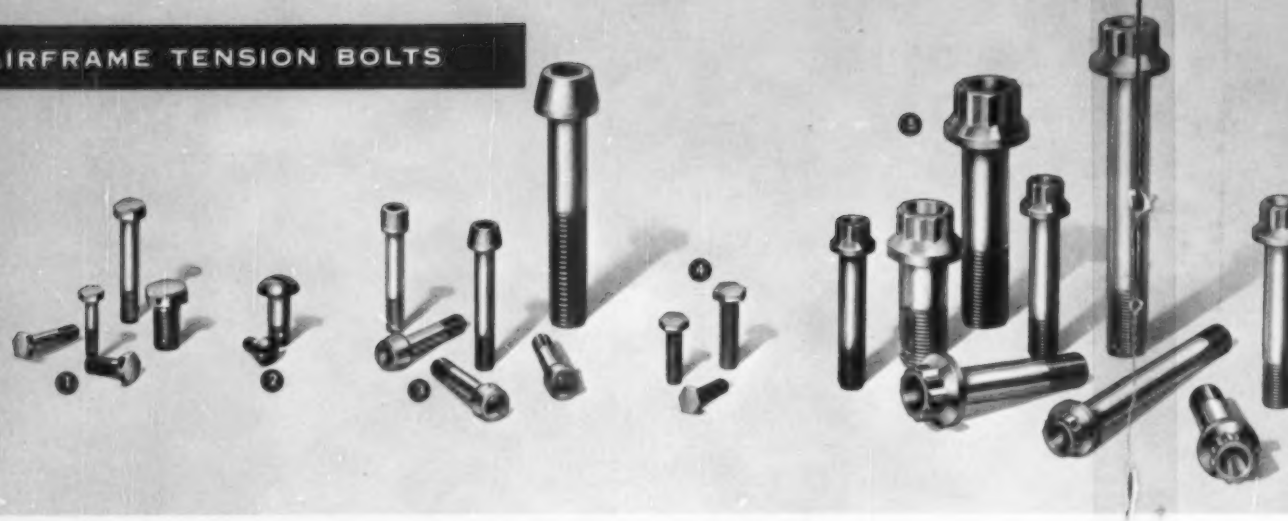
FOR THE AEROSPACE INDUSTRY

AIRCRAFT/MISSILE Division **sps**

ORMANCE PRECISION FASTEN

SPS HIGH-PERFO

AIRFRAME TENSION BOLTS



Shear strengths from 95,000 to 156,000 psi. Temperature range to 900°F. Extensive line of NAS and MS Series, along with SPS high-performance types. Variety of wrenching recesses. Furnished in aircraft quality alloy and corrosion-resistant steels and—where appropriate—in new super alloys. Wide choice of plating and other finishes. Can be supplied drilled or with Nylok locking pellet in thread. Heads forged; threads fully formed after heat treat.

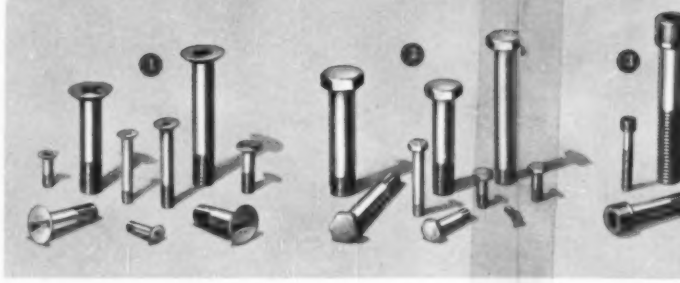
❶ **100° Flush Head Bolts:** Complete line of NAS Series. Also SPS high-strength, high-temperature types—SFH and SFT 22, 922, 26 and 926. Internal hex, Phillips, Torq-Set* or Hi-Torque† wrenching recesses. Shear strengths to 156,000 psi. Service temperatures to 900°F.

❷ **Hex Head Bolts:** Selection of NAS Series in shear strengths to 95,000 psi. Serviceable to 550°F.

❸ **Socket Head Cap Screws:** MS type with internal hex wrenching socket. 95,000 psi shear strength. Serviceable to 550°F.

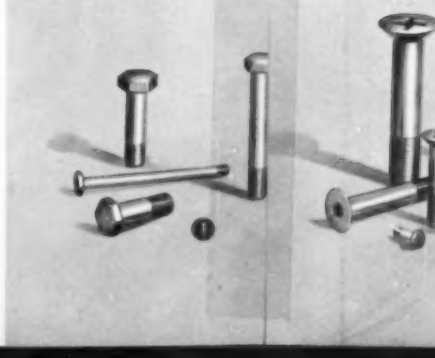
❹ **12-Point External Wrenching Bolts:** SPS high-strength, high-temperature types (EWSB 22, 922, 26, 926). Shear strengths from 132,000 to 156,000 psi. Service temperatures to 900°F.

AIRFRAME SHEAR BOLTS



Selection of NAS, AN, MS and SPS types offering shear strengths to 95,000 psi; tensile strengths to 160,000 psi. Available drilled, undrilled or with the Nylok self-locking element. Titanium aircraft bolts, first developed by SPS, weigh 43% less than their alloy steel counterparts. Yet in tensile strength-to-weight, they outperform steel. SPS Hi Ti titanium bolts are forged to retain continuous grain flow at the critical head-shank juncture. Fillets under the head are cold worked for increased fatigue life. Threads—fully formed by rolling after heat treatment—have a wider root radius to minimize stress concentrations.

TITANIUM BOLTS



❶ **Hex Head Bolts:** NAS and AN Series. Shear strengths to 95,000 psi.

❷ **100° Flush Head Bolts:** NAS and AN Series. Phillips, Torq-Set* or Hi-Torque† wrenching recesses. Shear strengths to 95,000 psi.

❸ **Hi Ti Lockbolts‡:** Complete line of shear and tension types, pull or stump, protruding or 100° flush head. Shear strengths to 95,000 psi; tensile strengths to 150,000 psi.

❹ **Internal Wrenching Bolts:** MS type. 150,000 psi tensile strength.

❺ **12-Point External Wrenching Bolts:** NAS 624 type. 160,000 psi tensile strength.

*Pat. No. 2,847,894 †Pat. Nos. 2,677,983; 2,745,120

‡Manufactured by SPS under Huck Pat. Nos. 2,527,307; 2,531,048; 2,531,049; 2,754,703

ORMANCE PRECISION FASTEN

Broad selection of AN, NAS and MS Series, plus SPS high-strength, high-temperature types. Tensile range from 110,000 to 260,000 psi; service temperatures to 1600°F. Materials include aircraft quality alloy and corrosion-resistant steels and many of the new super alloys. Bolts furnished drilled, undrilled or with the Nylok* self-locking feature. Plating per your specifications or to meet specialized service conditions. Heads forged to retain continuous grain flow into shank. Threads fully formed by rolling after heat treatment. *T.M. Reg. U.S. Pat. Off., The Nylok Corporation

❶ **Hex Head Bolts:** Complete line of AN and NAS Series. Tensile strengths from 125,000 to 160,000 psi. Serviceable to 550°F.

❷ **Clevis Bolts:** AN type. 125,000 psi tensile strength. Serviceable to 550°F.

❸ **Internal Wrenching Bolts:** Complete line of AN, NAS and MS Series. Tensile strengths from 125,000 to 180,000 psi. Serviceable to 550°F.

❹ **Crown Hex Head Bolts:** NAS type. 125,000 psi tensile strength. Serviceable to 550°F.

❺ **12-Point External Wrenching Bolts:** Extensive line of NAS and MS Series, plus SPS special high-performance types (Hi Psi EWB 22, LWB 22, EWB 26; EWB 1615; EWB Tm 9). Tensile strengths from 180,000 to 260,000 psi. Service temperatures to 1600°F.

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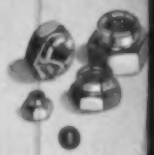
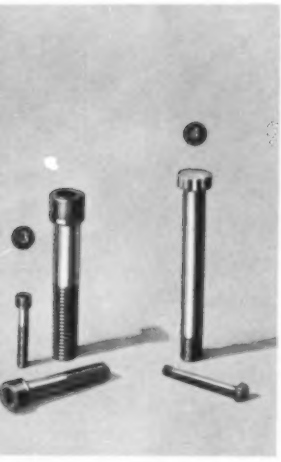
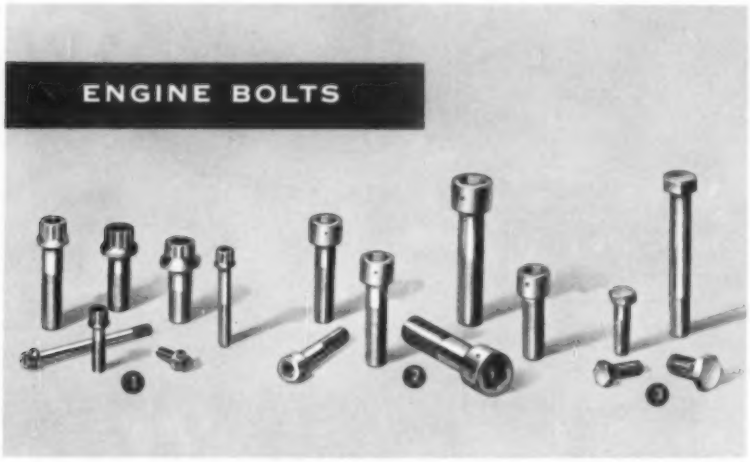




ENGINE BOLTS



Complete line of AN, M
or with Nylok self-lock
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performance bolts have
root radius for greater

❶ **12-Point External**
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❷ **Internal Wrenchin**
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❸ **Hex Head Bolts:** C
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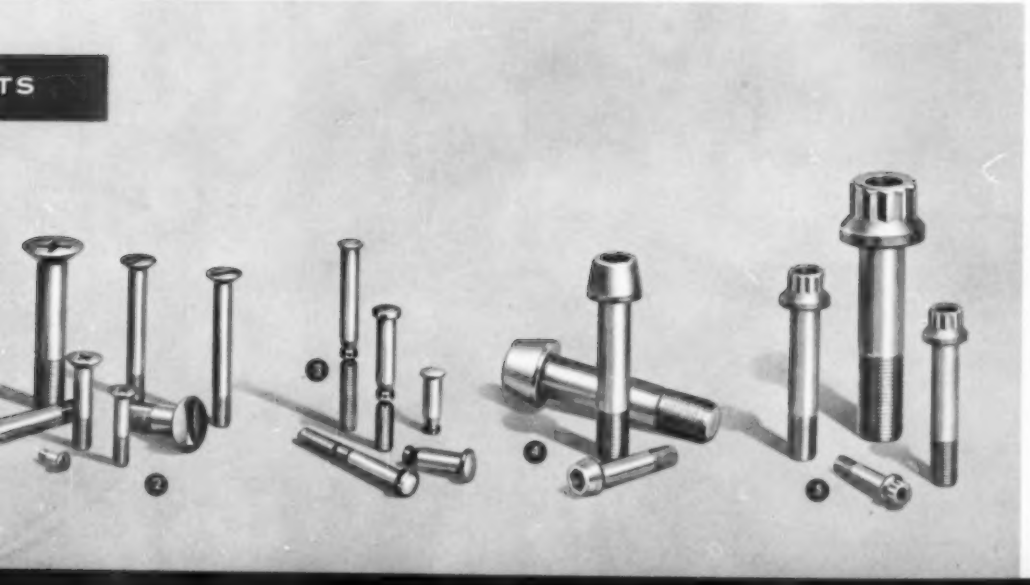


OTHER S

STENERS FOR THE AEROSPA

STRUCTURAL AIRCRAFT LOCKNUTS

Complete line of AN, MS and SPS types—undrilled, drilled or with Nylok self-locking feature. Tensiles from 110,000 to 260,000 psi. Temperatures to 1600°F. Furnished in aircraft quality alloy and corrosion-resistant steels and in new super alloys, plated or otherwise finished to meet application needs. Heads forged to retain continuous grain flow. Threads fully formed by rolling after heat treatment. High-performance bolts have SPS Hi R thread form with increased root radius for greater fatigue resistance.

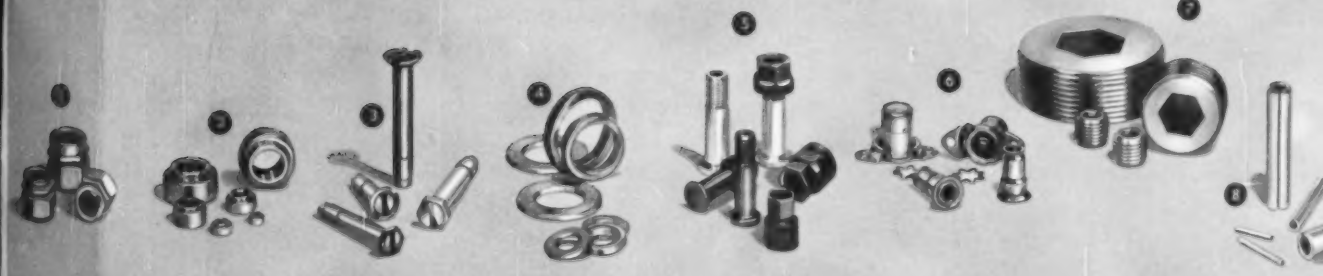
1 12-Point External Wrenching Bolts: Extensive line of MS Series, plus SPS special high-strength, high-temperature types (BE 1615, Hi Tm 9). Tensile strengths from 125,000 to 260,000 psi. Service temperatures to 1600°F.

2 Internal Wrenching Bolts: AN type with internal hex wrenching socket. 140,000 psi tensile strength. Serviceable to 550°F.

3 Hex Head Bolts: Complete line of AN and MS Series. Tensile strengths from 110,000 to 125,000 psi. Service temperatures to 1200°F.

PLATE NUTS

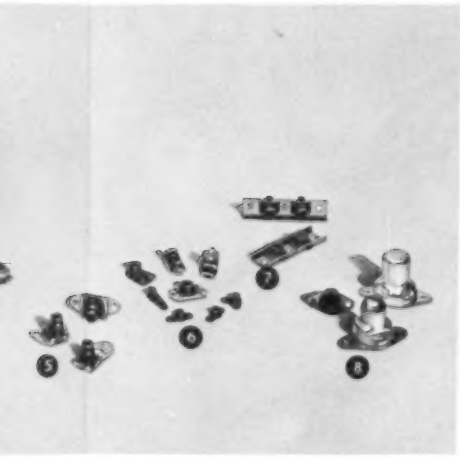
OTHER STANDARD FASTENERS



PACE INDUSTRY

SPS locknuts assure high-performance, minimum-weight joints when used with companion SPS bolts. Cadmium-plated carbon and alloy steel; nickel or nickel-cadmium plated AMS 6304; silver-plated austenitic stainless steels; and silver-plated A-286 (SPS-M-118) alloy. Complete range of standard sizes.

❶ **FLEXLOC Full-Height Locknuts:** 22 FSD Series for tension applications to 125,000 psi; temperatures to 550°F. For AN 3-type bolts. (Meet MS 20365, AN 363, AN 365, NAS 1021.) ❷ **FLEXLOC Thin Nuts:** 22 FT Series. Primarily for shear applications on bolts with shear strengths to 95,000 psi. 550°F max. (Meet MS 20364, AN 364, NAS 1022). ❸ **High-Beam FLEXLOCs:** 990 F12, 990 FR12 Series for temperatures to 1200°F. For MS 9033-type tension bolts to 125,000 psi. ❹ **High-Temperature FLEXLOC Locknuts:** 99 F12, 99 FR12 Series for service to 1200°F. For bolts such as MS 9033 having a minimum tensile of 125,000 psi. (Meet MS 20500.) ❺ **Lightweight Hex Locknuts:** 22 FZ Series for tension bolts to 125,000 psi and shear bolts with 95,000 psi shear strength. 550°F max. For AN 3 and other bolts. (Meet NAS 679.) ❻ **Featherweight Hex Locknuts:** FN 12, FN 812 Series for tension bolts to 145,000 psi and shear bolts of 132,000 psi shear strength. Serviceable to 550°F and 800°F respectively. Used on wide variety of aircraft bolts. ❼ **12-Point High-Strength Shear Locknuts:** EWSN 22, EWSN 922 Series. Primarily for shear applications on bolts with shear strengths to 132,000 psi. Also EWSN 26, EWSN 926 Series for shear bolts of 156,000 psi shear strength. Serviceable to 550°F and 900°F respectively. ❽ **12-Point Locknuts:** 42 FW, EWN 22 Series offering tensile strengths of 180,000 and 220,000 psi respectively. 550°F max. Also EWN Tm 9 Series for tension bolts of 220,000 psi. 900°F max. ❾ **12-Point Locknuts:** 119 FW Series for temperatures to 1200°F. Minimum tensile strength of 125,000 psi. For MS 9033 and other bolt series. ❿ **Lightweight 12-Point Locknuts:** 42 FLW Series for tension bolts (MS 20004, NAS 624) to 180,000 psi. 550F° max. ⓫ **Featherweight 12-Point High-Strength Locknuts:** FN 22 Series for tension bolts of 220,000 psi. 550°F max. ⓬ **Featherweight 12-Point High-Temperature Locknuts:** FN 920 Series for temperatures to 900°F. Tensile strength of 200,000 psi. Also FN 1216 Series for temperatures to 1200°F. For tension bolts to 160,000 psi.



Nutt-Shel lightweight self-locking type conforming to NAS 679 through NAS 1068 where applicable. Threaded elements furnished in alloy steel, cadmium plated, or corrosion-resistant steel, silver plated (also in other finishes). Designed to meet AN-N-10 and/or MIL-N-25027 (ASG). Alloy steel nuts serviceable to 550°F; corrosion-resistant nuts to 900°F. In floating-type nuts ("Timesavers"), threaded element is readily removable, reusable.

❶ **Fixed Anchor Nuts:** One-lug, 2-lug and corner types in flush and 100° countersunk styles.

❷ **Floating Anchor Nuts:** One-lug, 2-lug, corner and right-angle types.

❸ **Hex Nuts:** Internal-external wrenching and forged featherweight types.

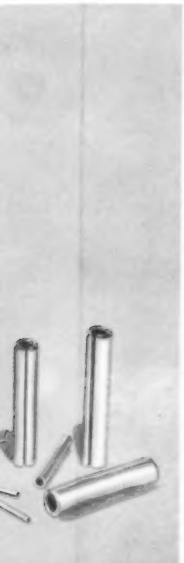
❹ **Floating Clinch Nuts:** Alloy steel only.

❺ **Floating Spacer Anchor Nuts:** One-lug, 2-lug and corner types.

❻ **Miniature Fixed and Floating Anchor Nuts:** One-lug, 2-lug, corner and right-angle types.

❼ **Gang Channel Nuts:** Plain, self-aligning and dome types.

❽ **Self-Sealing Floating Dome Nuts:** Two-lug and corner types; also 2-lug miniatures. BUNA-N-base synthetic rubber or silicone rubber seal.



Besides producing complete lines of airframe bolts, engine bolts, structural nuts and plate nuts, SPS is continually developing new types of fasteners to meet the many specialized demands of present-day aircraft/missile design. Representative of these special-purpose fasteners are:

❶ **Self-Locking Coupling Nuts:** One-piece, all-metal, self-locking type for fuel, hydraulic and oil lines. Style CN 8 in alloy steel, cadmium plated, for service to 550°F; CN 8C in corrosion-resistant steel, silver plated, for service to 800°F. Interchangeable with existing AN and MS couplings. ❷ **Swage Nuts:** Simple, economical means of putting load-bearing threads in sheet metal—without special tools. Carbon steel, cadmium plated. 160,000 psi tensile strength. Serviceable to 550°F. ❸ **Sleev-Lock Blind Fasteners:** 100° flush head or hex head styles in aircraft alloy steel, heat-resistant stainless steel, or titanium. Can be removed without drilling and reused. Shear strengths from 95,000 psi up. ❹ **Preload Indicating Washers:** More accurate than torque wrenches, because friction between mating threads is not a factor. Correct preload indicated when compressible inner ring is plastically deformed to same thickness as thin outer ring. ❺ **Speedy-Bolt Assembly:** New shear fastener for airframe panels. Quickly and easily installed from one side. Protruding or flush-head styles. ❻ **Structural Panel Fasteners:** Standard and self-sealing types in 2-lug and corner floating-receptacle styles. Available in alloy steel for service to 550°F; in corrosion-resistant steel for service to 700°F. No special tools required. ❼ **Pressure Plugs:** New Levl-Seal design permits flush installation. Plugs seal without compound. Available in heat-treated alloy steel, zinc or cadmium plated; anodized aluminum alloy; and magnesium. (Specification MIL-F-5509.) ❽ **Spring Pins:** Furnished in corrosion-resistant and carbon steel, zinc or cadmium plated or phosphate coated. Also in beryllium copper. (Specifications MS 9047 and 9048; MS 171401 through 171900.)

Fatigue testing center at SPS main laboratory in Jenkintown (Pa.) is the most extensive of its kind in the industry. This facility is currently completing a 3-year expansion.

Breaking the temperature barrier. A battery of new high-temperature stress rupture machines used in the SPS laboratories to test for stress rupture under service-simulating conditions.

With such equipment, SPS developed the first fatigue and shear compilations for fasteners under heat.

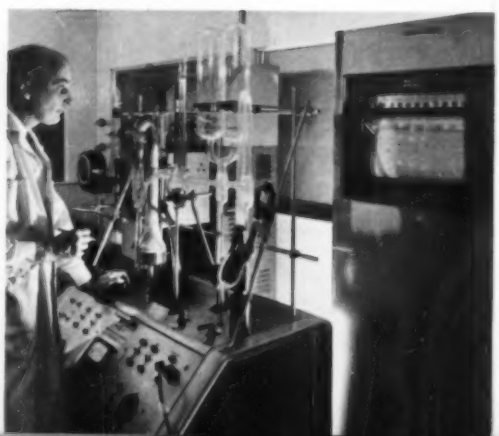
Greater Reliability...

Through Research

Convinced that reliability factors of all aircraft/missile components were due for radical upgrading, SPS undertook several years ago an unprecedented program of basic research in fastener design and performance. Today SPS maintains a fastener testing center that is second to none. Its facilities for mechanical, physical, chemical and metrological investigation are unsurpassed in the industry.

Emphasis on research has led to development of SPS aircraft/missile fasteners with increasingly higher strength-to-weight ratios, longer fatigue life, and greater resistance to the deteriorating effects of heat. This applies not just to a few highly specialized products, but to the entire line of SPS aircraft/missile fasteners—bolts of all types, companion locknuts, and other threaded parts. Whatever your application needs, SPS makes it easier for you to design joints offering a high degree of performance reliability.

SPS Metrology Laboratories are a new service established to help fastener users solve difficult thread fit and gaging problems. Identical facilities are located at Jenkintown, Cleveland and Santa Ana plants.



Taming super metals. SPS chemical laboratory technician uses elaborate hydrogen determinator to detect traces of element which robs titanium of its uniquely desirable characteristics.

MEETING THE FASTENING NEEDS OF THE SPACE AGE

The accelerating growth and highly specialized needs of the aerospace industry have imposed on its suppliers an urgent demand for new and ingenious designs, advanced production methods, and greatly increased product reliability. In the field of threaded fasteners, SPS has not only kept pace with this demand, but also has often anticipated it—in terms of research and development, testing, new manufacturing techniques, and an increasingly diversified line, now including Cooper and Nutt-Shel products.

The SPS line of precision threaded fasteners—illustrated and described on the following pages—is the most comprehensive ever offered the aerospace industry. From this extensive selection, you can specify a fastener for almost any current need. And where you have a new or unusual fastening problem, SPS offers unique capabilities in research, design and fabrication. Thus whatever your threaded fastener requirements, SPS is in a position to meet them.

PRECISION AIRCRAFT SPECIALS

SPS offers a virtually unlimited service in special-design threaded fasteners for aircraft and missile applications. Currently it is supplying such parts for high-performance turboprop, turbojet and rocket engines, super and hypersonic airframes, missile guidance systems, and nuclear aircraft engine development projects. These custom fasteners can be furnished in a wide range of materials, including aircraft quality alloy and corrosion-resistant steels, titanium and other exotic metals, including molybdenum, columbium and beryllium. Whatever your requirements in specials, SPS has the engineering capabilities and production facilities to meet them.

SPECIAL LOCKNUTS

Special lock and stop nuts are also an important part of SPS aircraft/missile fastener production. Included are square nuts, conical-seating nuts, shank nuts, barrel nuts, closed-end clinch nuts, and many other types—in a complete range of materials. A selection of these nuts is shown here as an indication of the numerous variations SPS can supply to meet special needs.

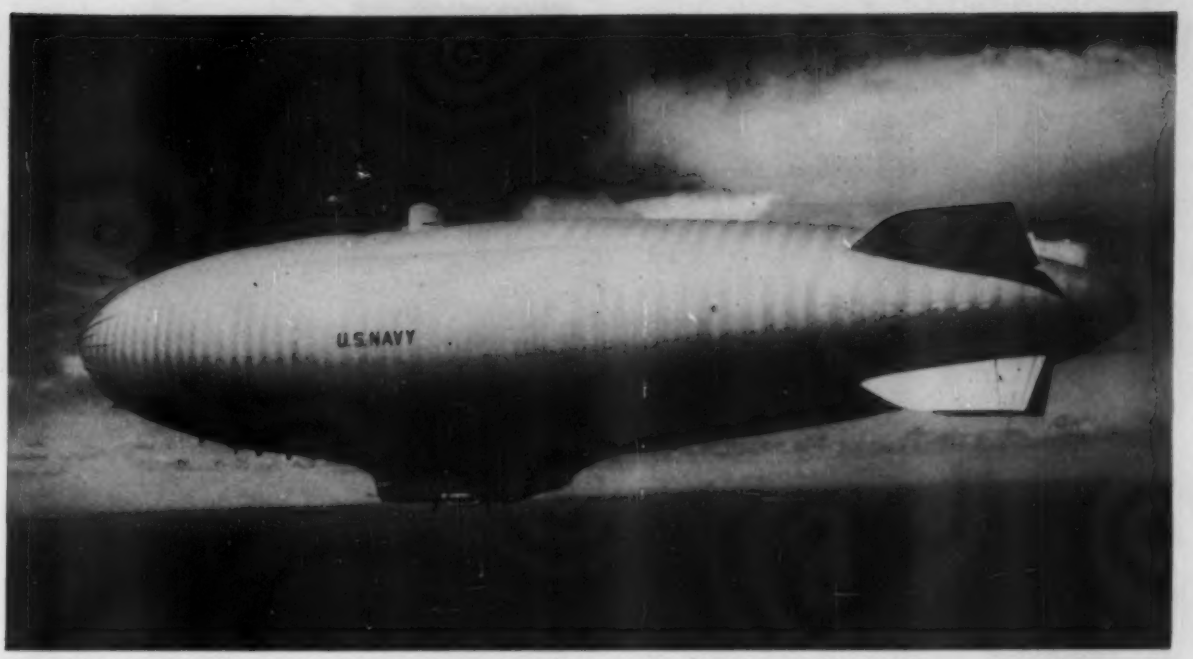
The services of the SPS engineering and research departments are always available to you for assistance in fastener design and development. If you have a particular project you would like to discuss, contact Aircraft/Missile Division, SPS. STANDARD PRESSED STEEL CO.

Reprints of this insert are available on request

AIRCRAFT / MISSILE Division SPS

JENKINTOWN 3, PENNA. • SPS WESTERN, SANTA ANA, CALIF.

FORM 2529 659-100M PRINTED IN U.S.A.



GOODYEAR ZPG-3W, airborne early warning airship, carries a 40 ft. search radar aatenna within its helium envelope. Pod atop the airship contains height-finding radar. The 403 ft. blimp has an absolute ceiling of 10,000 ft. and a useful load capacity of 22,907 lb.

First Goodyear ZPG-3W Blimp Delivered

By Barry Tully

Lakehurst, N.J.—First of four Goodyear ZPG-3W airborne early warning airships ordered by the Navy was accepted here recently after completing a 72 hr. simulated operational mission. A Goodyear crew piloted the airship with Navy pilots aboard as observers.

Upon completion of testing by the Airship Test and Development Department at Lakehurst, the blimp will join Airship AEW Squadron One for duty on the seaward flank of the Continental Air Defense Command's contiguous radar barrier. The Navy's present schedule calls for the first ZPG-3W to be on operational duty by October of this year and for all four to be operational by July, 1960.

The four ZPG-3Ws, the largest nonrigid airships ever built at 1.5 million cu. ft. helium volume, are being produced by Goodyear under a $48 million Navy contract. This contract resulted from the success of the ZPG-2W, an anti-submarine warfare airship modified for AEW operation. Goodyear says that the ZPG-3W could be produced in quantity at a unit cost of $3.5 million; however, the Navy has budgeted no new funds for airship procurement. Advantages of the new blimps in the area of airborne early warning include:

• **Large antenna carrying** capability. The ZPG-3W's 40 ft. search radar antenna for its APS 70 radar, contained within its helium envelope, is the largest airborne antenna.

In addition to the APS 70 search radar, the ZPG-3W carries height-finding radar in a pod atop the airship.

• **Long endurance.** The 25 man capacity of the ZPG-3W takes advantage of this by permitting alternate use of two complete crews while on early warning patrol.

• **Easy station keeping** over a fixed geographical position. The blimp, by nosing into the wind and maintaining an airspeed equal to that of the wind velocity will hover over its station.

• **Lower noise and vibration,** which tends to increase the efficiency of the crew. This is particularly important in the case of radar observers who must spend long periods watching the scopes.

The 403 ft. length and the 85 ft. maximum diameter of the ZPG-3W give it a fineness ratio of 4.7. The 83 ft. control car is connected to the height-finding radar pod atop the airship by means of an 85 ft. vertical tunnel made of rubberized fabric with stiffeners to prevent its collapse from helium pressure. Crew members climb the shaft to service the height-finding gear and, if necesary, to take celestial navigation sightings. A lighted window in the shaft permits visual inspection of the main search antenna.

The control car is similar to the ZPG-2 airship's. The car is built with two decks, the lower for the flight station, radar control and other crew

Boundary Layer Blimp

The Navy, in an effort to increase the speed of its blimps, is conducting experiments with boundary layer control on a ZP-5K airship. Present work, being led by Dr. August Raspet of Mississippi State University, has involved measuring the pressure along the blimp's surface to determine the optimum location for placing the boundary layer intakes. This is believed to be on the helium envelope about one-third of the way aft.

Dr. Raspet, now collating his data at Mississippi State, will return to Lakehurst to direct the installation of a boundary layer control system on the ZP-5K airship. The results of this test installation will determine the feasibility of modifying all Navy airships with boundary layer control.

Preliminary design studies indicate that boundary layer control combined with other design refinements, such as smoothing out the blimp's nose battens, may increase the airship's range by a factor of three and its speed by 40%.

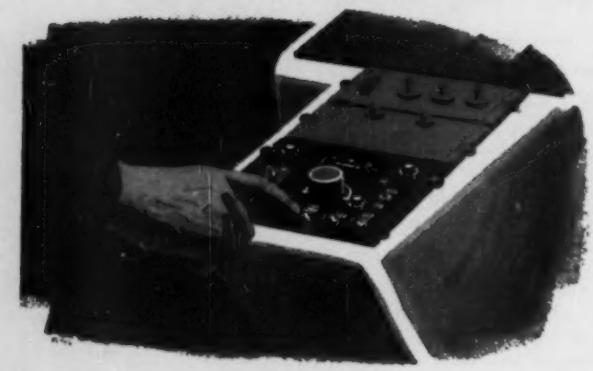
For airline efficiency, top executive planes are equipped by **SPERRY**

The list of blue chip companies selecting Sperry instruments and controls reads like "Who's Who of Industry."

Lockheed's four-engine JetStar, developed for military and corporate use, will fly executives at near sonic speeds over a 3,000 mile range, and have efficiency provided by Sperry SP-40 Automatic Pilot. The new aircraft will be ready for delivery in 1961.

Now...Specifically Designed For Utility Jets

SP-40 AUTOMATIC PILOT



PUSH BUTTON CONTROLLER
By pushing buttons on 3" x 6" controller, pilot engages system and can select the following optional modes: radio, heading hold, altitude hold or Doppler.

PROVIDES COMPLETE AUTOMATIC FLIGHT
Like the Sperry systems designed for the Douglas DC-8 and Convair 880 jetliners, the Sperry SP-40 provides hands-off control during cruise and, at the touch of a button, couples the aircraft to radio beams for automatic landing approaches.

DESIGNED FOR HIGH ALTITUDE FLIGHT AT NEAR SONIC SPEEDS
The SP-40 is a combination gyroscopic and inertially controlled electro-mechanical system which controls attitude, altitude and Mach of planes flying at near sonic speeds and at altitudes previously considered impractical for utility or executive-type planes.

LIGHT, COMPACT, SIMPLY INSTALLED AND EASILY MAINTAINED
The complete SP-40 Automatic Pilot System consists of 6 components whose total weight is only 80 pounds. The use of transistors and printed circuitry not only makes this low weight and compact size possible, but also assures high performance and simple installation and maintenance.

FOR TURBO-PROPS TOO
The features of the SP-40 which make it ideal for turbo-jets are equally applicable to turbo-prop planes.

AVAILABLE NOW
The SP-40 is available now for utility jet aircraft. Call or write for information.

SPERRY

AERONAUTICAL EQUIPMENT DIVISION, *SPERRY GYROSCOPE COMPANY • DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, N.Y.*

stations, the upper containing the galley, mess and sleeping quarters.

The airship powerplants are two Wright R-1820-88 engines rated at 1,525 hp. maximum and fitted with Curtiss Electric propellers. Chief advantage of the increased power of the 3W over the 2W is better single engine performance.

Other advantages include greater range and endurance.

Cruising speed of the ZPG-3W, approximately 70 kt., makes traveling upwind a tedious business. Airship proponents say, however, that time lost cruising to and from station is made up by the blimp's increased endurance.

AMC Contracts

Wright-Patterson AFB—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Kropp Forge Co., Chicago, Ill., removal and preparation for shipment of facilities, (PR-PB-9-F-9043), $60,200.

Pomona Division, Marquardt Aircraft Co., Pomona, Calif., 46 ea., AN/GPS-T4 radar target simulators, spare parts, ground support equipment, data and services, (PR's Pe-9-69-4116 and PE-9-9610-4357), $800,000.

Haller, Raymond and Brown, Inc., State College, Pa., one ea., converter, video signal, CV-668(XA-1, for use with IR AN/AAR-9 (photo reconnaisance), (PR PE-9-ST-3748), $169,178.

Collins Radio Co., Cedar Rapids, Iowa, 36 ea., indicators, Collins P/N 331C-4A; 36 ea., couplers, Collins P/N 161B-1; 36 ea., mountings, Collins P/N 349L-2, to be used in support of B-52 aircraft, (PR EC-9-16A-4669), $54,501.

Vitro Engineering Co. Division, Vitro Corp. of America, New York, architectural engineering, construction inspection service for RF induction heating system, (PR PD-9-8-1060), $88,363.

Lear, Inc., Grand Rapids, Mich., phase II VGI systems consisting of: 84 ea., indicators, attitude remote, type MM-3, Aerno 60-5939; 670 ea., gyroscopes, rate switching, type MC-1, Aerno 60-5938; 17 ea., indicators, attitude, remote, type ARU-4/A, Aerno 60-5942; two ea., amplifiers, attitude, remote, type ARU-3/A, Aerno 60-5941; 274 ea., gyroscopes, displacement roll and pitch, type MD-1, Aerno 60-5937; 274 ea., indicators, attitude, remote, type MM-4, Aerno 60-5940; lubrication, engineering and maintenance data for B66 aircraft retrofit and supply replenishment, (PR's SB-9-01D-B66-1373 and MA-9-05C-531), $532,181.

General Electric Co., Erie, Pa., 829 ea., generators, 300 amp., 30 v.d.c., type MA-8, Aerno 42-2019, G.E. model 2CM75F2, and data for C-124 aircraft, IFB 33-600-59-159(PR SA-9-03C-8351), $368,399.

Charles Beseler Co., East Orange, N. J., 252 ea., projectors, still picture, type AP-4, spare parts, drawings and literature, end use; ground support equipment, IFB-33-600-59-122(MIPR RO-2-990155-SC-01-23), $44,100.

International Latex Corp., Dover, Del., 5 ea., full pressure suit assemblies for test and evaluation, (PR EM-9-RD-6331), $54,687.

Jack & Heintz, Inc., Cleveland, Ohio, 300 ea., starters, engine, electrical, direct cranking, aircraft, 28 v.d.c., with slotted mounting holes, P/N 4202-AN4116R3B, Aerno 42-8805, for H18, H21 and H34 aircraft, IFB 33-600-59-153(MIPR R59-5397-TCSMO-E), $88,020.

Protection, Inc., Division, Mine Safety Appliance Co., Los Angeles, Calif., 2 ea., improved models of neck ring assembly, contractors P/N 1381; two ea., prototype neck ring assemblies, per requirements of exhibit WCLDBF 59-26, progress reports and drawings, (PR 56777), $26,257.

New Deutsch "Snap-In" Miniature Connectors

make RELIABILITY a REALITY

Here's a snap-in miniature you can trust to do what it's supposed to do. The new Deutsch DS Series of quick-disconnect connectors—with insertable and removable contacts and crimp-type terminations—has been thoroughly tested and *proved* under extreme environmental conditions.

Check these *proven* **advantages against your design requirements**

	DS FEATURES	YOUR DESIGN REQUIREMENTS
1 Pins and sockets	Easily insertable and removable	
2 Terminations	Crimp-type	
3 Contact retention	Withstands minimum of 25 lbs. pull	
4 Crimp strength	Greater than the wire itself	
5 Hand tools	Simple, fool-proof crimping, inserting and removal tools	
6 Interfacial seal	Continuous dielectric separation without voids; no bonding, reversion or shrinkage of inserts	
7 Environmental	Meets or exceeds MIL-C-26482 (ASG)	
8 Temperature	−100°F. to 300°F.	
9 Push-pull coupling	Positive ball-lock design; operates in direction of plug travel	
10 Contact size	Immediately available in #20 size; others to follow	
11 Shell size	Immediately available in 3, 7, 12, 19, 27, 37 and 61 contacts	
12 Interchangeability	Mates with existing Deutsch DM5000, DM6500 and DM9000 series	
13 Assembly	Delivered completely assembled except for insertion of contacts	

For complete technical information and test report, contact your Deutsch Representative or write us for Data File H7.

The Deutsch Company

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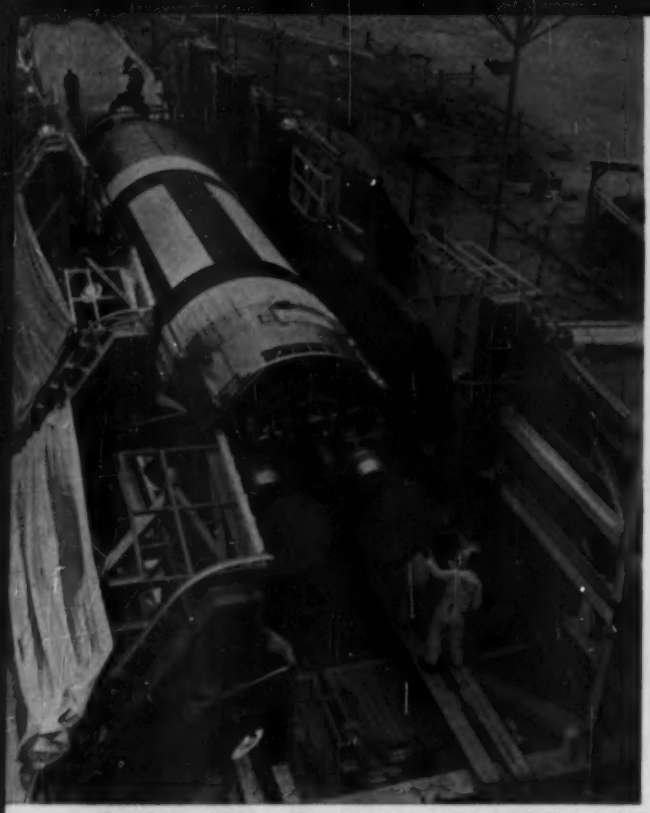
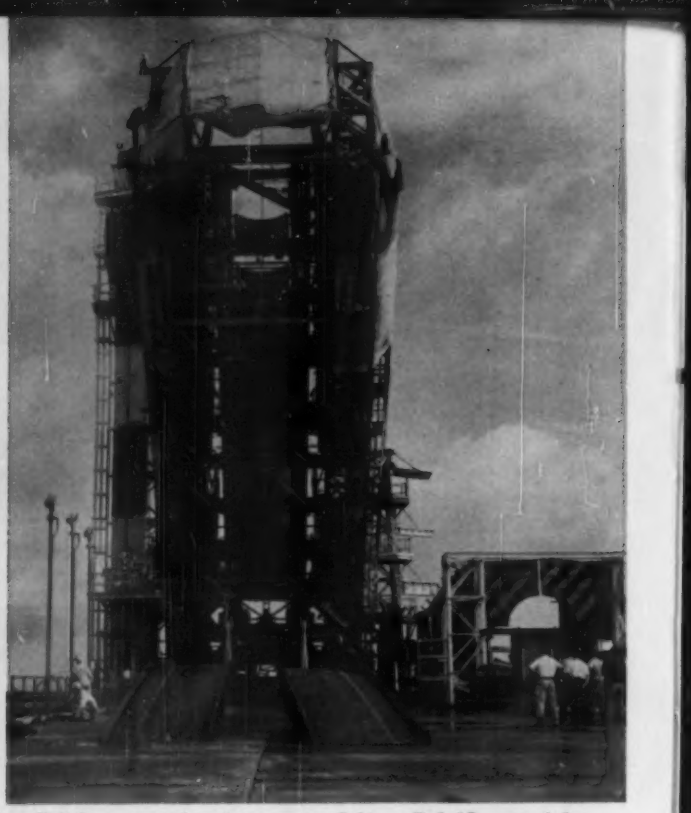
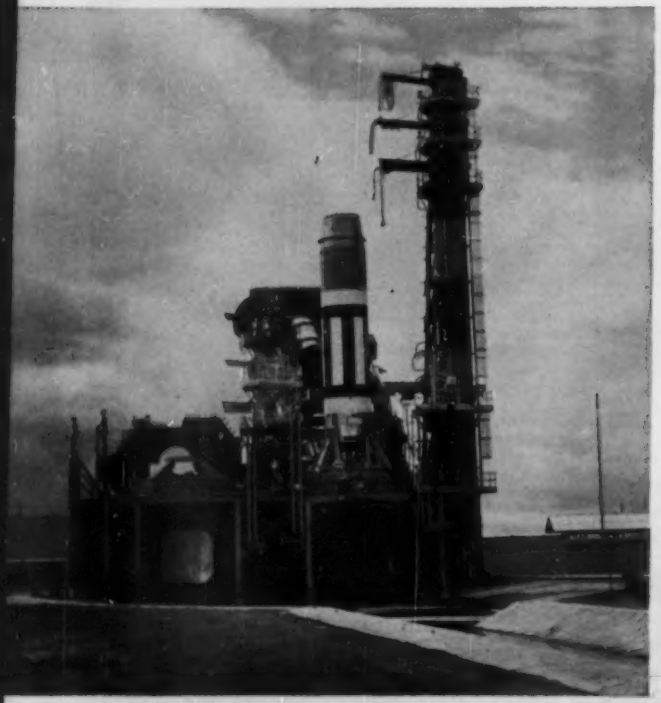
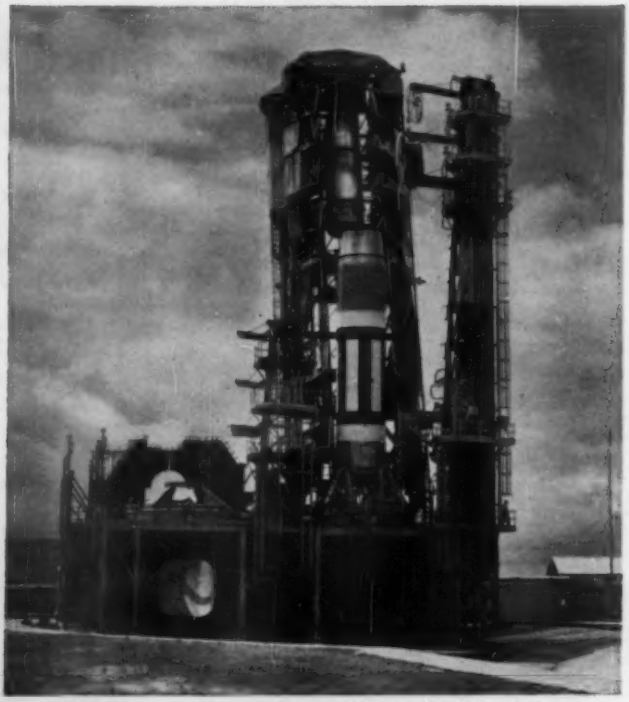




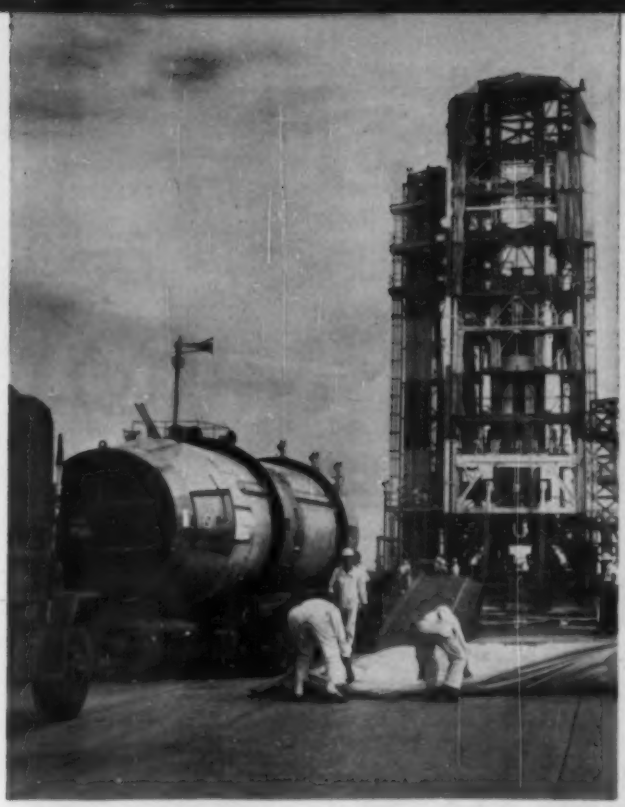
First stage of Martin Titan A-4 intercontinental ballistic missile is rolled from transtainer into erector (left) at Pad 15, one of four Martin pads at Air Force Missile Test Center's Cape Canaveral, Fla., complex. At right the 54-ft.-long, 10-ft.-dia. first stage is erected.

Titan Erected for Flight Test at Cape Canaveral

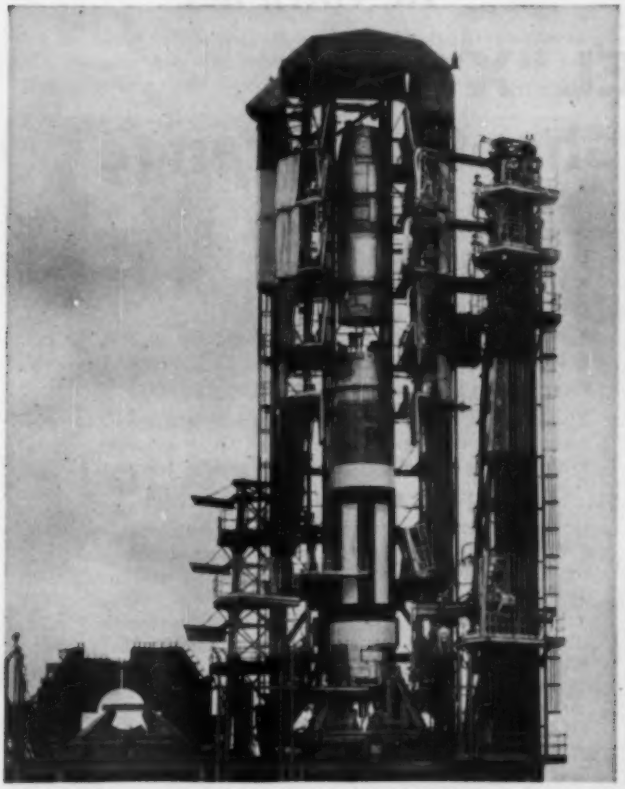




Second stage is lifted to position. Static firings of the second stage can be conducted on the smaller mounting to the left of the one holding the first stage. This smaller unit has its own flame bucket and erector. Umbilical tower at right is 92 ft. high.



Titan second stage's protective covering is removed and rolled up (left). The second stage is 37 ft. long and 8 ft. in diameter. At right the first stage has been positioned and the erector is lowered to receive the second stage. Assembled Titan is 90 ft. long.

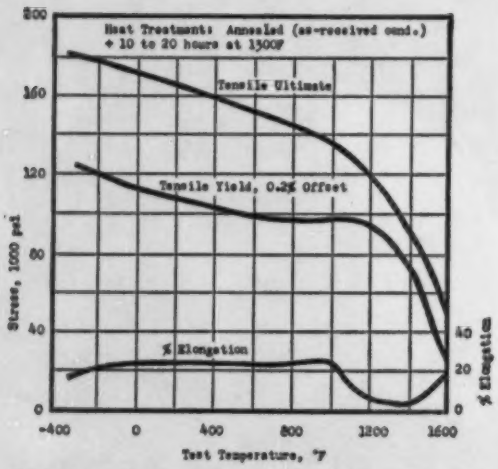


Second stage is lowered onto the first stage (left) after it is raised directly over the first. Note handling slings around second stage which facilitate this operation. Nose cone of the Titan A-4 is being attached at right, underneath the top of the 104-ft. erector.

Space cold

Re-entry hot

INCONEL "X"...
when you want sheet with range



Typical tensile properties of age-hardened Inconel "X" alloy sheet. Note strength at high and low temperatures. Much higher strengths are the additive effects of cold work and age-hardening.

Need sheet metal with high mechanical performance from space cold to glowing red heat?

- High impact strength down to liquid oxygen temperatures
- Room temperature tensile strength up to 220,000 psi
- 100-hr rupture life of 25,000 psi at 1500°F
- Oxidation resistance through 2,000°F

You can put all these high-performance properties into missile-age designs with Inconel "X"* age-hardenable nickel-chromium alloy sheet. See graph, left.

Favorable fabrication properties

With heat treatment, Inconel "X" sheet may be given a wide range of strengths and hardnesses. In addition, this versatile metal is formed, welded and machined by standard methods.

You can order Inconel "X" sheet in standard mill sizes. Inconel "X" rod, bar, strip, seamless tube as well. Want more information? We'll be glad to send further data at a word from you.

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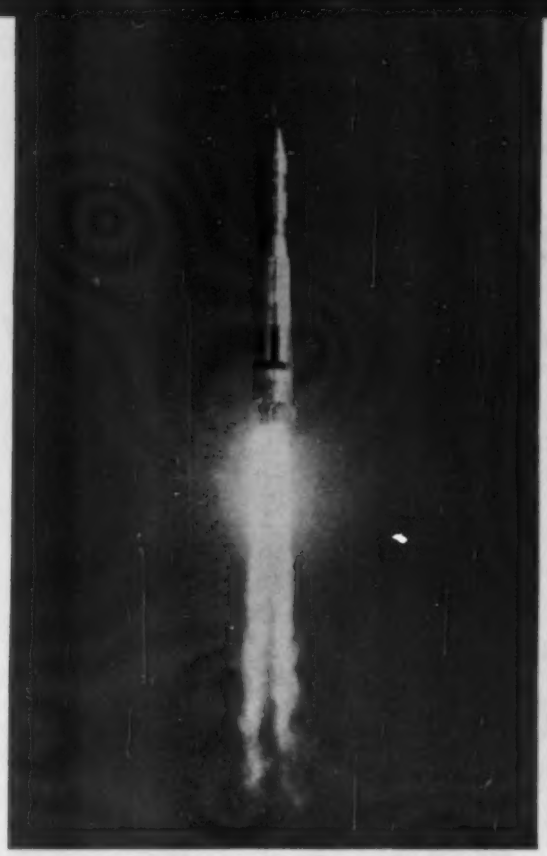
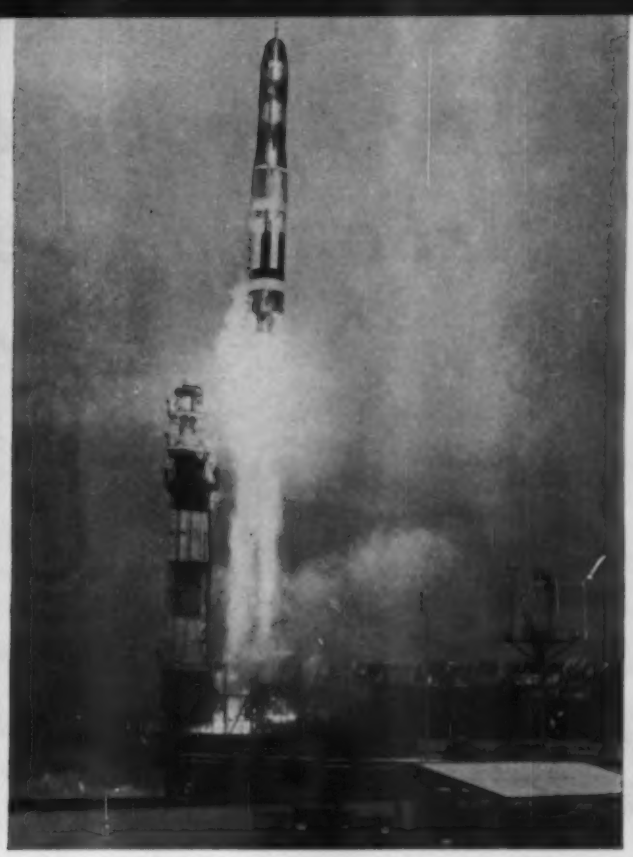
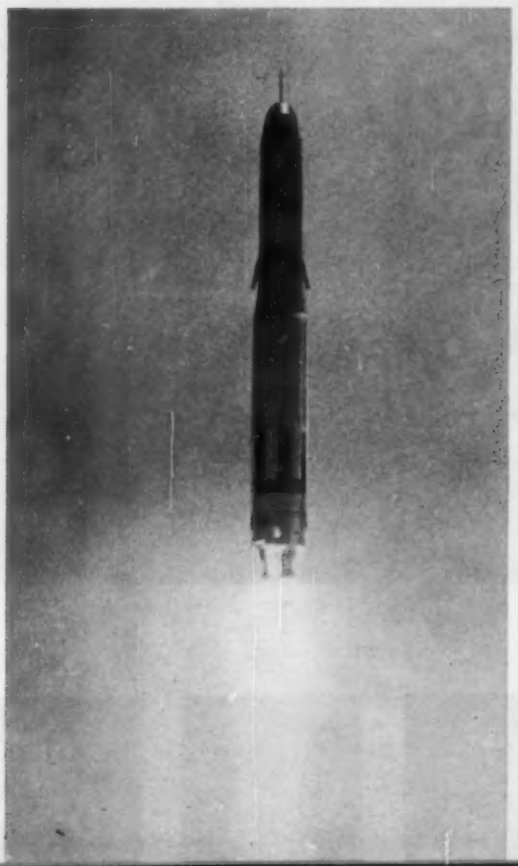
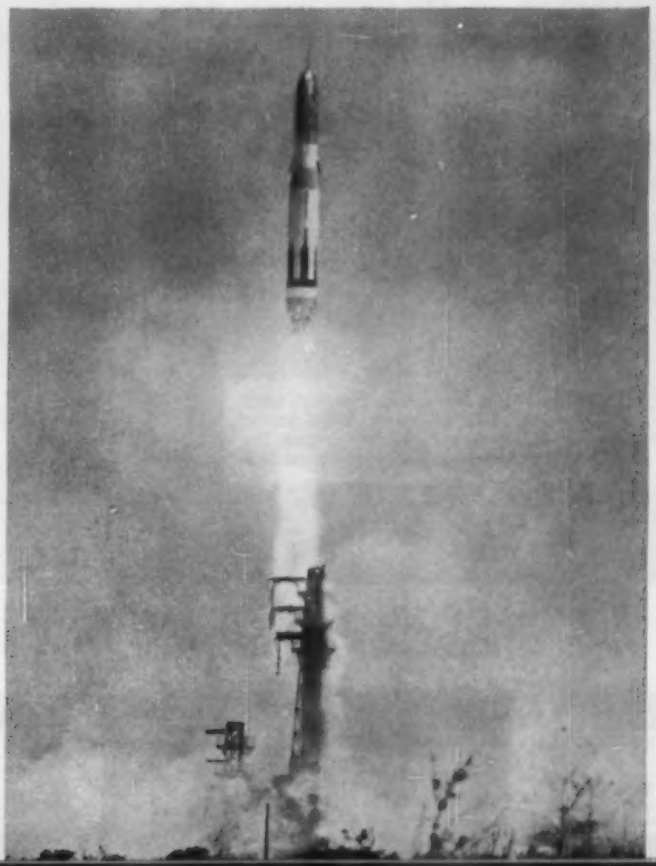
INCO NICKEL ALLOYS





First successful launch of the Martin Titan ICBM was of the A-3 vehicle Feb. 6 (left, above). Next came the A-5 Feb. 26 (right, above). The next firing, April 3 (below, left), was of the A-4 vehicle which was the first Martin attempted to fire but which was held on the pad twice because of malfunctions. It was returned to the Martin-Denver plant for repair of a broken liquid oxygen line and returned for the third successful shot. The fourth shot (below, right) using the A-6 vehicle was the first in which the second stage was separated. JATO bottles provide a small amount of added thrust to effect separation.





Holley Announces A Nationwide Service Network of Commercial

Service or replacement of Holley's compressor bleed governors, bleed pistons and bleed valve actuators is now immediately available throughout the U.S.

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In 14 key areas throughout the U. S., there is now a competent Holley service shop readily accessible to airlines flying the Boeing 707 or Douglas DC-8. These service outlets are fully equipped and stocked branches or main service departments of three well-known aviation parts and service distributors: Pacific Airmotive, Southwest Airmotive, and Airwork.

Each of these distributors has personnel specially trained in the servicing of Holley aircraft products and each maintains a stock of both assembled units and components of Holley compressor bleed governors and actuators. Replacement or service of these jet engine accessories is literally only minutes away from any metropolitan center.

If you would like a complete brochure of Holley products, facilities, and service outlets, simply address the Aircraft Division at Holley.

West Coast and other Western states airlines and commercial customers are serviced through the several branches of the Pacific Airmotive Corporation and its subsidiaries

The handsome new facilities of the Southwest Airmotive Corporation at Love Field, Dallas, Texas, are headquarters for Holley sales and service for Dallas and other south Texas areas.

East Coast and Southeastern sales and service are provided through the organization of the Airwork Corporation and its several branch locations.

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Synchros have to take punishment. They are often exposed to blistering heat and stratospheric cold . . . and they still must operate accurately.

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Ketay is the *only source* currently manufacturing and shipping a complete line of the new Mil-type synchros. They are available in production quantities in sizes from 8 to 23, with 60 cps units as small as size 15. Because of their superior accuracy, with some units offering 3′ accuracy at room temperature, Ketay synchros one or more sizes smaller than previously required may often be used.

Ketay engineers are working on many advanced environmental and accuracy problems in developing prototype systems, and have an unusual degree of experience in high temperature work. Why not call or write for help in solving your special problems?

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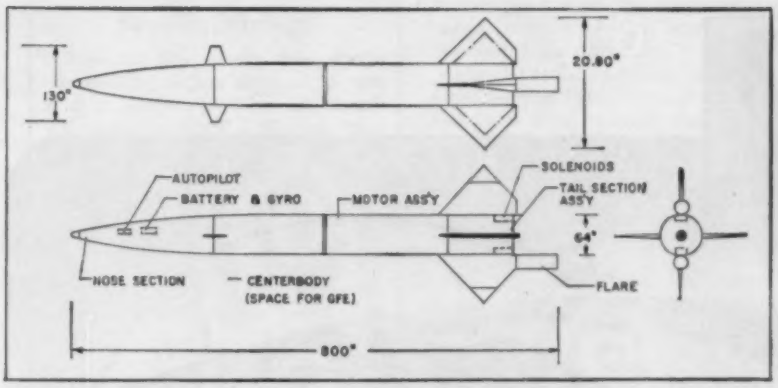


SCHEMATIC drawing shows top, side and front-section profiles of Curtiss-Wright Skydart.

USAF Orders Curtiss Target Drone

Santa Barbara—Rocket-powered aerial target for training interceptor pilots in attack and launch techniques for air-to-air missiles is being built under sponsorship of the Air Research and Development Command's Sidewinder Weapon System Project Office.

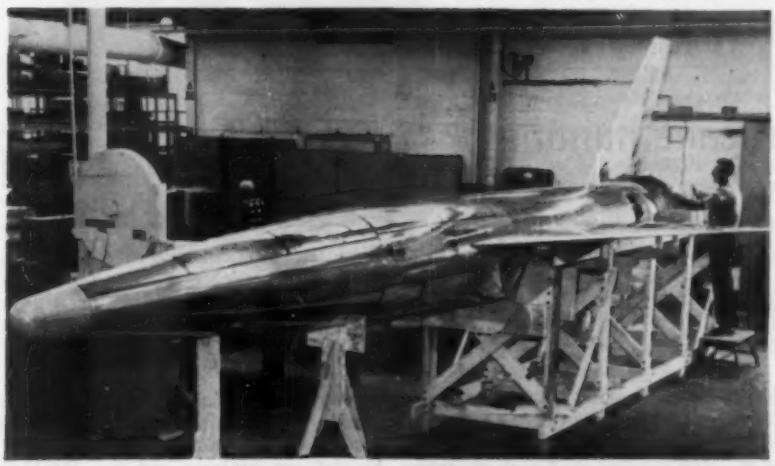
An undisclosed number of Skydart I TDU-12/B targets are being built by the Santa Barbara Division of Curtiss-Wright Corp. under a $470,000 Air Force contract.

The expendable, high altitude, intermediate range rocket-powered target is designed to be air-launched by either North American F-100 or Lockheed F-104 aircraft from GAR-9 rocket mounts. Parameters of the launching envelope are altitude of 40,000 to 60,000 ft. at Mach 0.80 to 2.00 (equivalent airspeeds from 180 to 350 kt.).

A dual thrust, solid-propellant rocket motor built by Grand Central Rocket Co. will supply power for a 90-sec. useful free flight during which the target will maintain altitude within 5,000 ft. of launch and airspeed which varies not more than Mach 0.80.

Trajectory of the target can be varied by ground adjustment of the angle of incidence of the canard surfaces. In flight, stabilization is achieved by servo-actuated flippers which permit a maximum of only 5 deg. variation in the roll axis. A flare on the tail of the vehicle provides a 90-sec. source-target for infrared-seeking air-to-air missiles and ignites automatically on launch.

The nose section which houses the flight control unit, battery, roll control



Republic Builds Swallow Mockup

First photo of a mockup of the Republic SD-4 Swallow reconnaissance drone shows delta wing configuration. Several test models will be built for flight test later this year. The Swallow is powered by a Pratt & Whitney JT12 turbojet engine (AW Oct. 27, 1958, p. 23) and is being built under a $30 million contract awarded by U. S. Army Signal Corps. Drone will use infrared detection, radar, photography and other sensory devices to report enemy activity back to a command post. Complete drone weighs 3,500 lb.

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"PERFORMANCE PROVEN"
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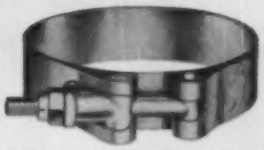

BAND CLAMPS—NUCO standard clamps are ideal for duct and nonmetallic hose connections. Numerous clamp designs and latch styles meet every need. These can be supplied with multiple latches, brackets or lugs, and special liners. Write for Catalog No. 14.

VEE-BAND COUPLINGS—NUCO sales engineers throughout the U.S. can assist you with your every coupling problem. An almost infinite number of standard couplings and flanges are available to meet your exact requirements. Write for Catalog No. 12.

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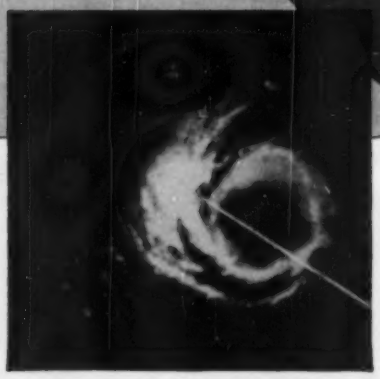

SKY HIGH

integrated hurricane hunting

A sky-high vantage point will be the key to the detection of spawning hurricanes over vast ocean areas such as the Caribbean Sea. Weather satellites equipped with special sensing devices will be able to report cloud patterns and rising columns of warm moist air which indicate the formation of these tropical storms.

Alerted by satellite information, weather reconnaissance aircraft will be dispatched to investigate the hurricane area. These aircraft, with the Bendix AN/AMQ-15 system, will employ high altitude rocketsondes, dropsondes, aircraft sensors, and cloud and storm radars to measure the meteorological and geophysical parameters that make it possible to predict storm intensity and motion.

Measurements of weather phenomena relayed from the AN/AMQ-15 system will be combined with data from land-based weather stations and upper air sites. These data will be integrated and processed by advanced weather computing centers to yield forecasts essential to military operations, commercial aviation and our civilian life.

Advanced weather and geophysical forecasting is the ultimate objective of the AN/AMQ-15 system and related projects being carried out at the Bendix Systems Division. These programs, air defense projects and the EAGLE Air-to-Air Missile program, will provide the integrated systems of tomorrow. Opportunities are available for better engineers and scientists also looking to the future.

Bendix Systems Division

ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

Javelin Firings

Beginning this month, three Javelin test sounding rockets designed to carry a 40 lb. payload to 1,000 mi. altitude will be fired at NASA's Wallops Island facility by Kirtland AFB's Special Weapons Center activity. Javelin is also known as Argo D-4, consisting of Honest John, followed by two Nikes and topped by an Allegany Ballistic Laboratory X-248 rocket.

Beginning probably in September, four Journeyman test sounding rockets, designed to carry a 40 lb. payload to 2,000 mi., will be fired at Wallops by Kirtland's Special Weapons Center group. Journeyman is an Argo D-8 rocket, consisting of a Sergeant booster, followed by two Grand Central Rocket Lances, and topped by an Allegany Ballistic Laboratory X-248 rocket.

Prime contractor in both projects is Aerolab Development Co., Pasadena, Calif., which is assembling the rockets, designing interstage connections, heat shields, aerodynamic features, spinning and despinning mechanisms, and payload separation devices. Firing crew will be from Kirtland, supplemented by an Aerolab field representative. Payload will accommodate 12 channels of telemetry to record performance data, including stability, acceleration and heat factors.

gyro and supporting brackets is spun from 6061-SO aluminum alloy and measures 22.5 x 6.4 in.

The center body measures 6.4 in. in dia. x 20.12 in. in length. In addition to supporting the canard surfaces, a 15-lb. payload is carried in the center section which is roll-formed and seam-welded from 6061-T6 aluminum alloy.

The motor section is formed of SAE 4340, 4337 or 4140 normalized steel and heat treated, measures 6 in. in dia., 22.5 in. long.

Destruct unit is incorporated to ensure termination of forward flight upon command electrical impulses from a CFP control device.

Nine Single Pads To Be Built for Atlas

Construction will start this fall on nine Convair Atlas missile launching sites dispersed in a radius of 60 mi. around Cheyenne Wyo.

The new sites will be single-launching pads and will cost an estimated $20 to $30 million. Construction is expected to take 15 months.

Work is now under way on four multiple launching pads each about 20 mi. from Cheyenne. Their total construction is estimated to cost between $65 and $100 million.

The nine newly authorized sites will be equipped with self-contained guidance systems so they can be more widely dispersed from Cheyenne.

Missiles at the initial four sites will be ground-controlled. Three of these sites will have three missiles each and the other will have six launchers.

Aerojet to Continue Army Work at Rheem

Los Angeles—Recent acquisition of Rheem Mfg. Co.'s Defense and Technical Products Division by Aerojet-General Corp. provides Aerojet with a ready-made facility to engage in Army programs.

Aerojet, already working on Air Force and Navy contracts, will continue Army programs already under way at Rheem's Downey and Riverside, Calif., facilities. Work under way includes powerplants for the Raytheon Hawk missile, nuclear warheads for Nike Hercules and the Army Rheem SD-2 surveillance drone system.

Downey Division, including the Riverside facility, will operate autonomously as does Aerojet's rocket engine plants at Sacramento and Aerojet Nucleonics at San Ramon, Calif.

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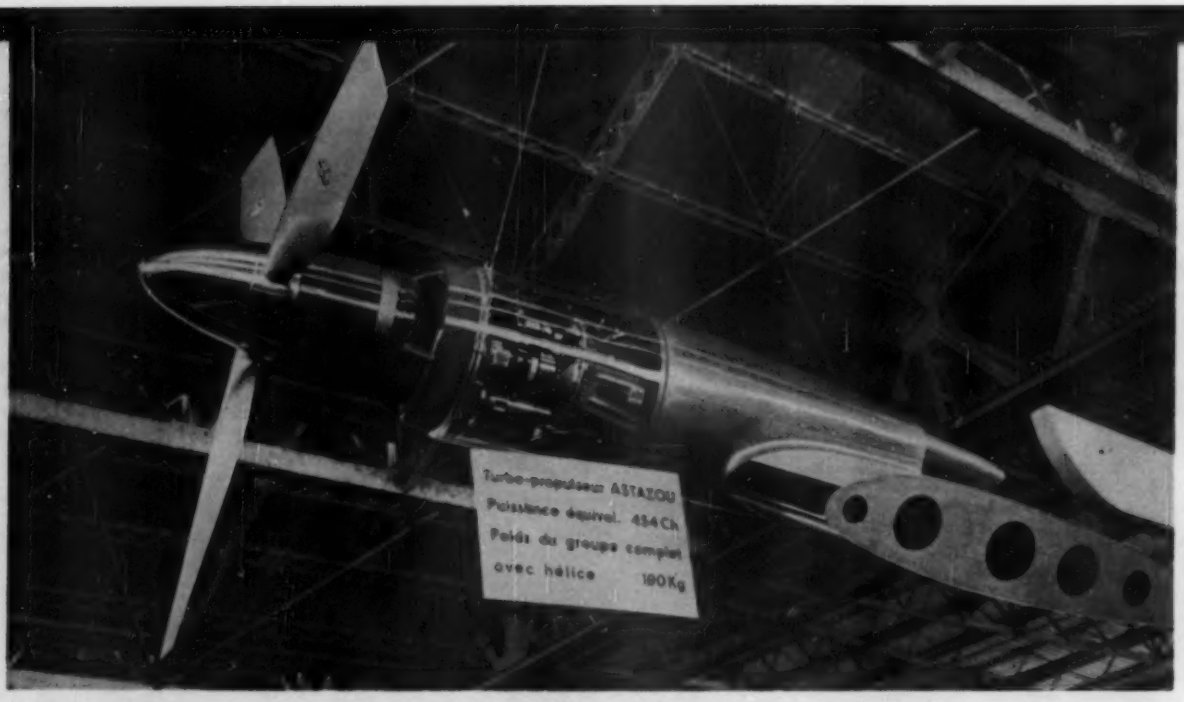
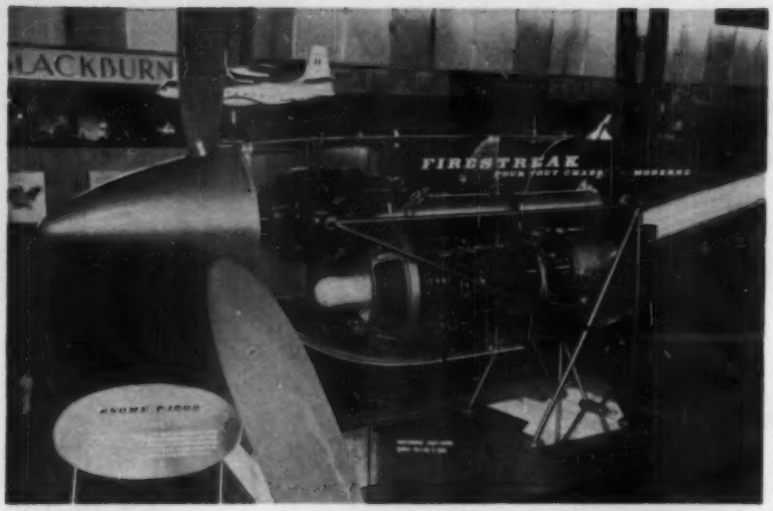
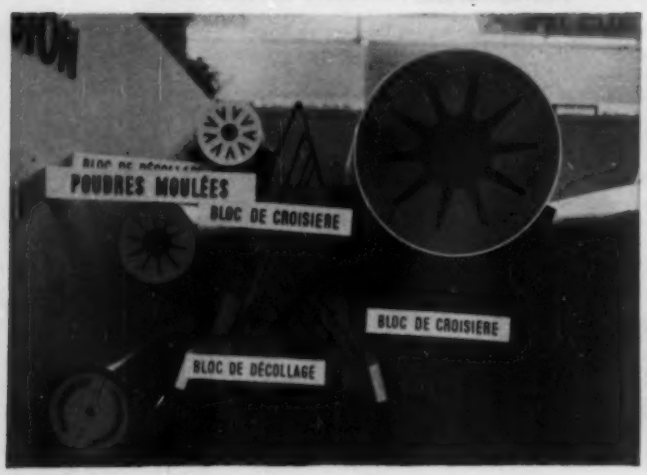


Turboprops, Solid Propellant Grains Shown at Paris

Cutaway of Turbomeca Astazou turboprop (above) is shown at the 23rd International Aeronautical Salon, Paris, in a trim installation with jet exhaust increasing total rating to 454 eshp. Weight of the complete installation, including propeller, is 420 lb. The Astazou is being tested in a Max Holste Broussard Type 153 (AW June 29, p. 62). Engine develops 375 eshp. continuous. Fuel consumption is 278 lb./hr. De Havilland Gnome P.1000 turboprop (right) comprises the power section of the General Electric T58, built under license in Britain, plus de Havilland gear boxes, extension shaft, propeller and controls. First all-British Gnome ran June 5. The French Army Ministry showed cross-sections of solid propellant grains (below) which are in development or production. Booster grain at right is designed to provide high initial thrust.





Centrifuge Tests Pilot Re-Entry Control

By Richard Sweeney

San Diego, Calif.—Pilots in a new series of centrifuge runs at the Johnsville Naval Air Development Center simulating typical space vehicle profiles generally performed better at moderately high—4-6g loads—than they did under static conditions.

This was in spite of various handicaps such as straining, holding their breath, loss of peripheral vision or discomfort. Reports on the centrifuge runs by Randall M. Chambers and Harold V. Doerfel at the American Rocket Society meeting here and on the over-all program by John M. Eggleston and Donald C. Cheatham of NASA's Langley Research Center at the Institute of Aeronautical Sciences meeting in Los Angeles indicated that the pilots had most difficulty in certain types of runs at the upper end of the acceleration range—6-8g.

The work was similar to that conducted for the X-15 (AW June 8, p. 69), except that closed loop simulation covered a typical space vehicle.

Effort was aimed at determining the ability of highly skilled test pilots to control several basic types of vehicles under conditions in re-entry flight from a maximum altitude of 350,000 ft. to a minimum of 60,000 ft. Entry angles were tested ranging from 1-6 deg., circular orbits, initial vehicle velocities of 25,863 or 20,700 fps. and terminal velocities of approximately 1,300 fps. Vehicle characteristics were mostly those which would be associated with flying of high-drag, variable-lift trajectories.

Three Vehicle Types

Three basic types of vehicles which were simulated were: (1) a high drag, low-lift winged vehicle; (2) a high drag capsule, and (3) a glide capsule.

The centrifuge work was part of an over-all program which included research accomplished at Langley Research Center of the National Aeronautics and Space Administration on the requirements of stability-controlled deceleration and pilot techniques necessary for a controlled descent from orbit into entry of the earth's atmosphere.

In simulating the winged vehicle, the pilot performed while sitting in a normal flying position with normal head-to-seat vertical g forces. True attitude and angle of attack were displayed to him so that the negative lift-curve slope of the vehicle was apparent.

In the high-drag capsule simulation (second type), the pilot performed while sitting facing backward with his instrument display showing all angular displacement as though he were flying a conventional vehicle which was moving in the direction of his line of sight. To the pilot, the capsule had an apparent positive lift curve slope. Gravity forces were primarily positive transverse, i.e., chest to back. The capsule had static stability in pitch and yaw and none in roll. Damping about all three axes was varied from zero to optimum on different entries.

Aerodynamic controls were included on both the winged vehicle and the high-drag capsule. On the winged vehicle these took the form of flaps which could be extended from the winged surfaces to increase the exposed planform area and produce moments about the desired axis. For the high drag capsule, aerodynamic controls would consist of lateral and longitudinal flaps which were deflected to add to the frontal area of the vehicle and produce moments about the desired axis again. This capsule also had various degrees of reaction controls.

The glide capsule did not have the same high drag, low lift characteristics as the others. In this one the pilot faced forward looking along the flight path, with negative transverse acceleration, that is, back to front. Additionally, he was subject to positive normal acceleration; that is, head to seat. At high angles of attack his decelerations were evenly divided; at low angles of attack the deceleration was purely back to chest.

Most simulation for each vehicle was made with a "standard" value of static stability based on wind tunnel data provided by NASA. Static stability was, however, an important variable in the experiment and was programed at 4, 2, 1, ½, and ¼ of the wind tunnel values. Dynamic stability was also varied.

All vehicles had essentially no static stability about one axis. The vehicles had a low moment of inertia about the same axis and common lack of static stability was extremely obvious and required continuous attention by the pilot at all times to keep the desired orientation. With the addition of a very small amount of artificial static stability and roll, the pilot had much less difficulty in controlling the vehicle even with zero damping about all three axes.

The simulated re-entry of the two high-drag, variable-lift vehicles was started at 350,000 ft. altitude with velocity of 25,863 fps. Normal entry trajectories for the third vehicle developed such low deceleration that dynamic simulation on the centrifuge was not practical. Hence, the entry studied with this vehicle simulated conditions which would result from an aborted launch. These re-entries started at 275,000 ft. with a velocity of 20,700 fps. (0.8 satellite velocity). Lower initial altitude was used because the high load of the vehicle caused deceleration to occur at lower altitudes. Most re-entries terminated at about 60,000 to 75,000 ft. with a velocity of 1,300 fps., and flight path almost vertical. Such trajectories last from 5 to 10 min.

Display Instruments

Displays from which the pilots operated included the following instruments: acceleration, rate of descent, altitude, velocity, angle of attack, pitch angle, roll angle, (both pitch and roll were indicated on the center attitude indicator), and angle of attack error. Also shown were yaw angle and angle of sideslip.

The seat was a modification of the X-15 prototype. At the end of the pilot's right arm rest was a small finger-tip controller stick which the pilot used for pitch and roll control motions. The controller consisted of a small shaft with a knob at the top. The knob was 4 in. above the pivot point, and 2 in. above the top of the box. The unit was designed for electrical control systems, was spring loaded and had no intentional friction. Controller was designed to allow the pilot to operate the aerodynamic controls during high deceleration conditions that were both steady and oscillatory. Also, a small trim wheel was mounted to the right of the stick. In part of the program, this trim wheel was inoperative, and pilots were instructed to use a trim wheel which was mounted at the end of the pilot's left arm rest. Two rudder pedals were operated by small motions of the toes.

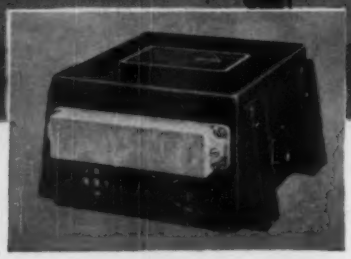
The aerodynamic controls and the jet reaction controls both were operated by the pilot through this one pilot control stick as well as rudder pedals.

Specific tasks included:

- **Maintaining a constant** angle of attack.
- **Making step changes** in angle of attack when decelerations reach a certain level.
- **Maintaining a constant rate** of descent.
- **Changing rate of descent** from initial value to some prescribed value and hold it.
- **Leveling off at a certain g value**, al-

duce the rate of descent or flight path angle to zero or some small value and bleed off velocity in this condition at

trination as to the characteristics of the vehicles to be flown during that period.



Shown is the Talon T-38 trainer, developed in parallel with the new N-156F supersonic jet fighter by Norair, a division of the Northrop Corporation. When the N-156F comes off the production line, it will carry Chatham power supply 28VS100BL-1—a 100 amp, blast-cooled, silicon unit especially designed to Northrop specifications.

Chatham power supplies selected for NORTHROP space-age jet fighter!

Northrop, to secure the finest quality materials and components for its new N-156F supersonic counterair fighter, called on over 575 different manufacturers, each a specialist in a particular field. For power conversion equipment, Northrop chose Chatham.

Chatham power supplies come highly recommended for use in military fighters. Performance of Chatham units in aircraft of all types points up their extreme reliability — an assurance emphasized by Chatham's enduring reputation as a maker of trustworthy electronic components.

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You can join Northrop and the many other airframe manufacturers that now profit from the benefits offered by Chatham power supplies. Send for folder T-16 that describes stock models! Or outline your needs and we'll design and make the original unit that best meets them. Chatham Electronics, division of Tung-Sol Electric Inc., Livingston, N. J.

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tial value to some prescribed value and hold it.

- **Leveling off at a certain g value,** allowing g to build up to but not exceed certain value and holding it there as long as possible.
- **Varying angle of attack** so as to hold zero error on angle of attack error indicator. For this, difference between actual angle of attack and angle of attack computed by an equation computer was shown to the pilot in the form of an error on a meter. Whenever the meter went off zero, the pilot changed his angle of attack in the opposite direction to return it to zero, i.e., a "fly from" situation.
- **Controlling angular motion** only (under conditions in which the pilot was given only reaction controls). Damp out oscillation.
- **Re-entering** as quickly as possible.

For the glide capsule, the first four tasks were used for early simulations, but the primary task used for most of the glide capsule simulations was to reduce the rate of descent or flight path angle to zero or some small value and bleed off velocity in this condition as long as aerodynamically possible.

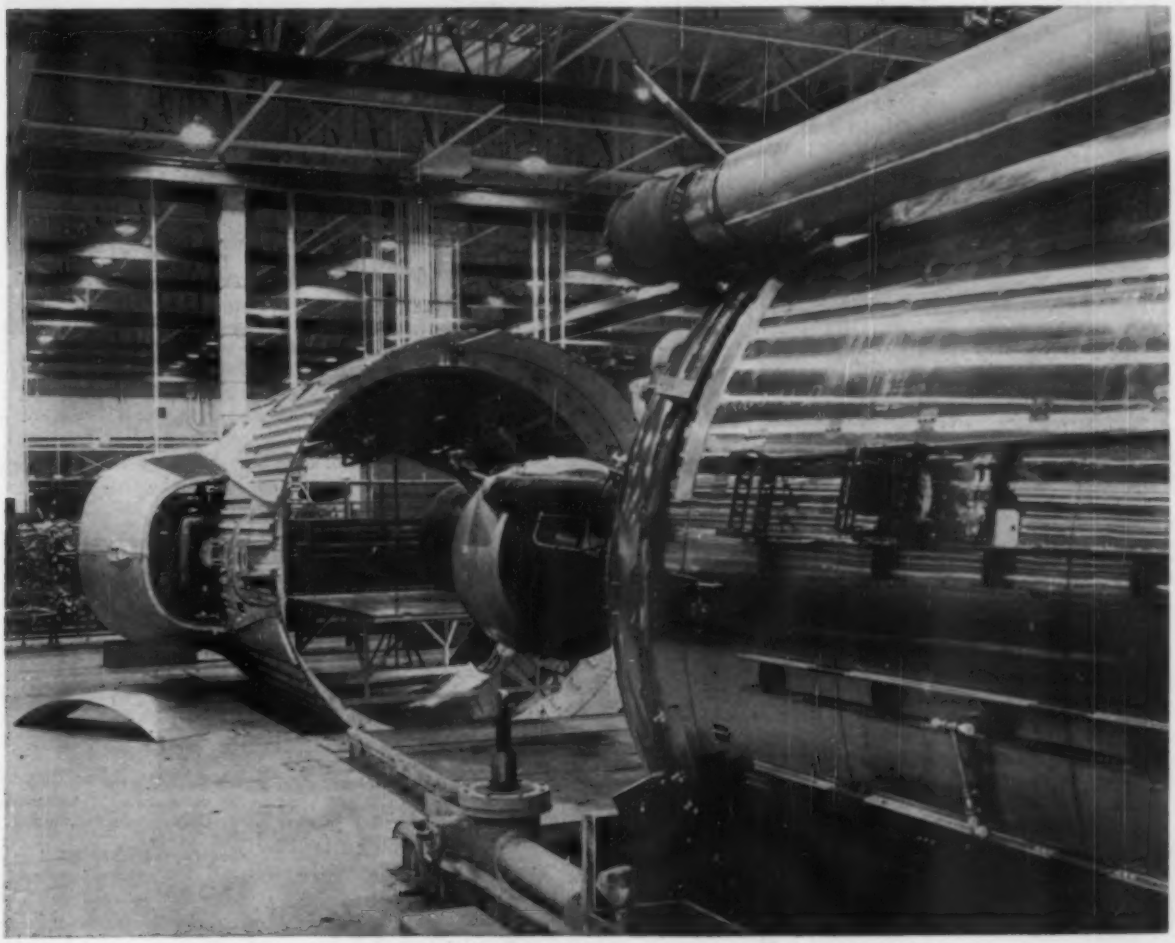
These specific tasks were studied because one of the principal difficulties in controlling an entry trajectory might be that the pilot would have no direct control over deceleration. By changing the angle of attack and producing a lift, the pilot could, after a period of time had elapsed, reduce the rate of descent and deceleration. It may be necessary in space vehicles for the pilot to anticipate in advance the effect of change in angle of attack on the deceleration. The task could be simplified by providing the pilot with an instrument giving information which reduces the anticipation problem.

The 10 men who served as subjects were from the Navy, Air Force, Marine Corps and NASA. They spent a week on the static simulator at NASA Langley Research Center before starting centrifuge work. They received indoctrination as to the characteristics of the vehicles to be flown during that period.

Experimental design of the program provided for static runs which could be compared against dynamic runs. In addition, there were provisions for progressively modifying vehicle characteristics in order to test all of the pilots and their maximum controllability limits. For any run, the pilot was briefed on conditions, vehicle characteristics and task requirements.

Consecutive Entries

Given a particular task and particular vehicle, pilots were required to fly consecutive entries with progressive changes in conditions. Generally these extended from acceptable or standard to regimes which are beyond the capabilities of a pilot to perform satisfactorily. Performance of the pilot was measured under conditions both of static and dynamic simulation, changes in performance were observed as functions of aircraft control characteristics,



Atlas Booster Separation Point

Convair Atlas intercontinental ballistic missile's booster (left), containing two 150,000 lb. thrust chambers, separates from the sustainer engine and tankage section (right) after booster thrust termination. The sustainer engine is rated at 60,000 lb. thrust.

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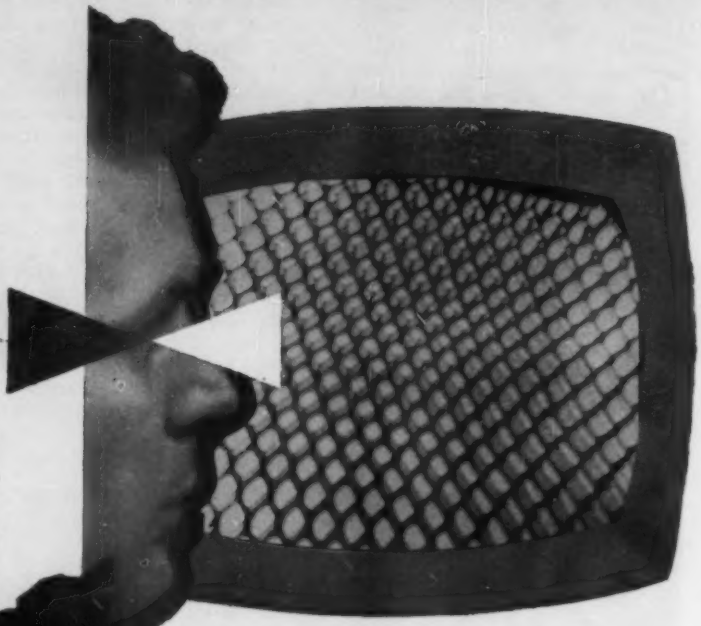

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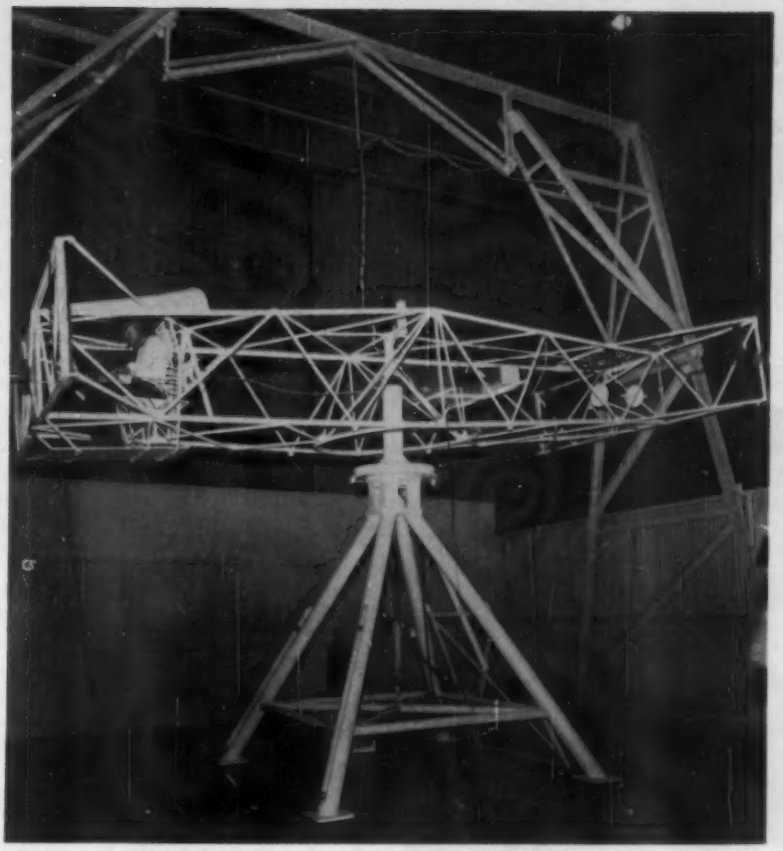

Space Vehicle Control Studied With Simulator

Boeing Airplane Co. reaction control simulator is used as a testbed for developing methods for controlling a space vehicle. Jet controls actuated by pilot or through an automatic control system slowly accelerate the simulator into varied pitch, roll and yaw positions.

and as functions of the accelerations to which the pilot was exposed.

Since there are as yet no criteria against which performance in these nonstandard simulated vehicles can be evaluated, there is a general absence of response frequency and amplitude data against which pilots could be compared.

Therefore, it was necessary to weigh heavily pilot opinion, plus reports by trained observers, to make value judgments about piloting proficiency under various tasks for the various vehicles in flight conditions. This was especially necessary in evaluating critical portions of the runs.

Physiological Problems

In addition, it was observed frequently that a poorly performed run may have been due to some physiological or support problem rather than task complexity.

Information on such variables was obtained largely by pilot interviews and comments.

Immediately following most of the runs and after a series of related runs, the pilot was asked a series of questions in order to assess his own opinions and feelings about:

- **Effectiveness** of the simulation.
- **His general performance** as well as his performance under specific tasks.
- **Physiological** discomforts and perceptions.
- **Description** of the tasks.
- **His method for preparing** for tolerating g stress.
- **His method of breathing** at high g levels.
- **Amount of effort** in making the flights.
- **Amount of concentration** necessary to make satisfactory flight.
- **Recommendations** about the support system.
- **Recommendations** about the controls displayed.
- **Over-all handling qualities** of the various simulator vehicles and their particular characteristics.
- **Use of static and dynamic** simulation in training space pilots.

At the upper end of the acceleration range (6-8g), dynamic runs were clearly the most difficult, were sometimes accompanied by aborts or excessive oscil-

PUMP PRIMERS

by
Arthur A. Nichols

"Gerotor Pumps Better Than Spur Gear Pumps?"

Yes, in most aircraft applications, Gerotor pumps are far superior to conventional spur gear pumps. This is a completely unbiased opinion because we are a leading manufacturer of both types and are committed to neither. In fact, the first pumps we made, back in 1926, were spur gear pumps. These accurate metering pumps now produce most of the rayon, acetate, celanese, nylon and other synthetic fibres spun all over the world.

But such aircraft applications as lubricating, scavenging and hydraulic systems impose far different requirements of speed, inlet conditions and mounting. These are the very conditions which Gerotor pumps are specifically designed to meet.

The superiority of Gerotor pumps for aircraft applications stems from their simple design — only two moving parts rotating in the same direction around a single shaft—and their exceptional adaptability to installation and space requirements. *(Fig. 1)*

Fig. 1.

The Gerotor pump's single shaft, with its single bearing reduces by one-half, the problems of locating, aligning and maintaining a spur gear pumps' two bearings. Tooth wear in Gerotor pumps is far less than in spur gear pumps having the same shaft speed. That's because Gerotor elements revolving in the same direction have lower relative speed. For example, in a pump with a 5-toothed outer Gerotor and a 4-toothed inner Gerotor, when the shaft is rotating at 1800 rpm, the inner and outer Gerotors are revolving at only 360 rpm in relation to each other.

Application adaptability is inherent in the Gerotor pump. By varying diameters, thicknesses and tooth sizes of Gerotor elements, a needed capacity can be built into a wide variety of housing dimensions. Multiple functions, such as lube, scavenge, boost, etc., can also be obtained by stacking Gerotor elements along a single shaft. *(Fig. 2)*

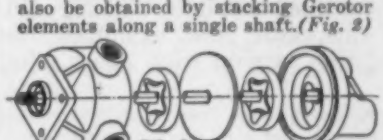

Fig. 2. Multiple function pump.

Technical data, engineering assistance and production facilities are available. Your inquiry is invited.

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lations due to poor performance. In most re-entries, pilot errors could produce high deceleration with oscillatory divergence. Additionally, steady deceleration produced a steadying effect on the pilot which made performance smoother than was to be expected. In dynamic runs, pilots worked harder, concentrated more, exerted more effort than during the static runs.

In all except the high g runs, the pilot was able to maintain a level of proficiency when physiological task stresses were added.

Also, at the higher g, it was frequently observed, the pilot did better on his primary piloting tasks, and performance suffered greatest on his secondary pilot tasks.

Of 360 runs and experiments, there were 23 pairs of runs in which the pilot was able to fly the static simulations, but when acceleration components were added, could not make successful reentry. These were aborted runs and were attributed to the acceleration components primarily. These aborts were due to excessive oscillations, pilot exceeding safety limits, difficulties encountered by the pilot in connection with his flight gear, difficulties in operating controls, inadequate head support, difficulties of peculiar sensations, and accidental stoppage by the pilot.

Additionally, pilots differed among themselves. These differences were most striking at the higher g levels, especially where there were major individual differences in the breathing techniques used, their ability to withstand sensation of compression of the lungs, choking sensations that were associated with long duration runs at high g. There were also individual differences in the piloting techniques which were used in operating the side-arm fingertip controls. Another difference was in the amount of experience pilots had had in prior work on centrifuges.

The attempt to evaluate after-effects of the acceleration produced by these types of vehicles on simple psychomotor skills suggested there were no measureable effects of these accelerations on these particular abilities, after about 20 min. following completion of dynamic runs. Similarly, there were no obvious disorientation effects 20 min. after the end of a series of runs, although some special tests involving autokinetic movement did indicate there were some post-accelerative effects of a very subtle nature.

Pilot Control

Pilots flying with normal positive acceleration resultants were able to maintain good vehicle control during high g deceleration (6 to 8g) for relatively long periods of time, ranging from one to two minutes. With a combination of positive normal and positive longitudinal accelerations which produced a resultant g force acting about 45 deg. to the chest, it was possible to fly about 90 sec. between 8-9g during simulations which lasted four minutes. Negative transverse accelerations from back to front were the most difficult for the pilots, within fields having these resultants, accelerations could be tolerated for only short periods of time at 3.5g, and pilots found it difficult to maintain focus of the eyes and control of their arms and legs.

Major modifications in g supports were recommended as a result of the study, and performance tolerance was directly related to hardware modification.

All pilots demonstrated good proficiency on all of the tasks, although improvement with practice was shown on some of the problems. Proficiency for holding a constant angle of attack, for making commanded step changes in angle of attack, was found to be very high. Holding a constant rate of descent required more attention, although changing rate of descent to a new value sometimes led to overcontrolling when the entry angle was large. It was found that the pilot when instructed to allow the deceleration to build up to a certain value and then hold that value, could maintain good proficiency for

He's Spotting Premature Removals

Cracks, finer than hairlines, sometimes form around spark plug inserts. Most of them are invisible to the naked eye at overhaul. But cracks grow as the cylinder ages in service. And a cracked cylinder means a field change knocking the stuffing out of your operating hour cost.

This cylinder has been heated in caustic soda; neutralized in nitric acid. Any cracks present —even the finest—stand out as fine black lines. The Airwork inspector now examines the area around each spark plug insert carefully . . . using a 20 power binocular microscope. He makes sure this cylinder will run through the entire operating life cycle without failure.

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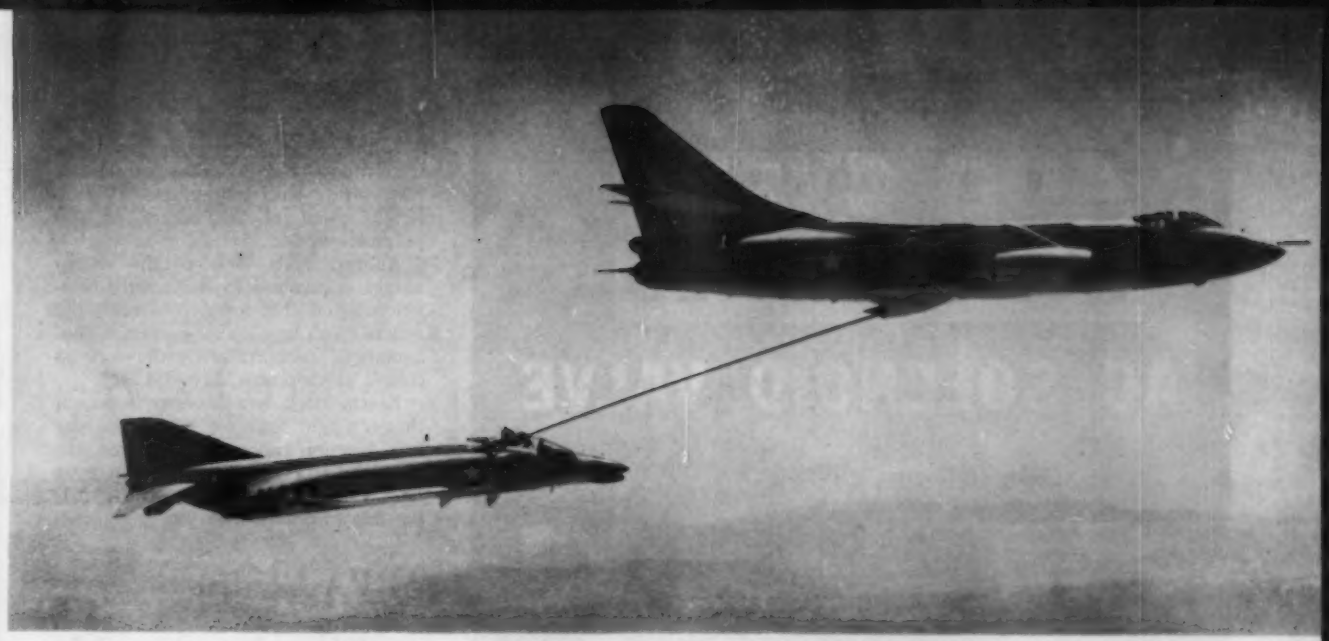

McDonnell F4H-1 Tests Air Refueling System

Flight test of air refueling system is made by number four McDonnell F4H-1 two-place all-weather Mach 2 fighter, which is shown with its probe tucked into drogue extended by Douglas A3D-2 Skywarrior jet tanker. F4H probe is extended alongside rear cockpit.

small entry angles and that with increasing entry angles it became more difficult. Anticipation was also more difficult as the re-entry angles became larger.

Pilots were able to fly complete re-entries with ½ of standard, and also with zero damping about all three axes of the high drag vehicles.

The pilots demonstrated the capabilities of the human pilot as a dependable component of the entire vehicle system during the simulations that were performed. Given an acceptable or low value for damping, the pilots could perform proficiently all of the tasks. Good dynamic stability was provided the aircraft configuration, changes in static stability had little effect on the pilot ratings as long as control power was changed to corresponding amount. The handling qualities of the three types of vehicles were not appreciably changed with the wearing of pressure suits.

Perception and interpretations of displays were accomplished effectively by the pilots.

It was concluded that the pilot as a human operator can effectively control entries along high drag, variable lift trajectories into the earth's atmosphere and that it is feasible for a pilot to control range and deceleration during high drag, variable lift trajectories.

Simulation suggested that the human operator can make piloted re-entries at angles up to 6 deg. without exceeding 8g.

End result showed the pilot can maintain control of the vehicle for several minutes, even under conditions of prolonged acceleration with vehicles having low dynamic stability.

Colloidal Propulsion Unit's Thrust Would Exceed That of Ion Rocket

San Diego—Performance of a charged colloidal propulsion system capable of yielding up to 100 lb. thrust for time periods approaching a year exceeds that of ion propulsion by at least one order of magnitude.

The system has been carried through the stage of demonstration of feasibility with Aerojet-General Corp. funding alone, Y. C. Lee, manager of Aerojet-General's Space Technology Division, told the American Rocket Society semi-annual meeting here.

Work on the system has been conducted by about 50 people altogether over the past year.

The system's advantages, Lee pointed out, include its ability to operate for extended periods of time due to its low working (space ambient) temperature operating characteristics, and its greater thrust at lighter gross system weights than are available with ion propulsion.

The colloid intended to be used as the working fluid has a specific gravity of 0.5, and when available as a commercial product should cost between 25 and 50 cents per pound. It is a readily available aggregate of particles which are submicron in size.

The system, capable of providing higher incremental velocity additions, could be used for navigation, propulsion, and attitude correction, as a prime space propulsion system, according to Lee, it would serve to considerably shorten space flight times due to its higher thrust, hence higher vehicle velocity, for flights such as those envisioned to the moon or other nearby planets.

The system could be used either for an orbit transfer type departure, wherein a vehicle in orbit increases its velocity until it reaches that required for escape, or it could be the final stage propulsion system after a vehicle has reached velocity by conventional chemical powerplants.

In addition to these roles, the system could be used to provide auxiliary power for the space vehicle's various additional systems, or provide a higher secondary power source required for any special purpose.

Work now is going forward with funding from Advanced Research Projects Agency, Lee said, adding that he considered the system feasible for flying hardware within three years, "if properly funded." Current ARPA funding is intended, according to Lee, to bring the system from its present feasibility demonstration status to "reduction to practice."

The colloid system will require at least megawatt electrical power source, in contrast to ion propulsion system, which requires several megawatts power. A nuclear reactor as basic electrical power supply is envisioned for the system.

The colloid material could receive its

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NON-RECTIFIED
AC SOLENOID VALVE

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Aero Supply has designed and built a 400 cycle non-rectified AC solenoid valve for precision high temperature operation or for immersion in JP-6 fuel. While this valve is designed for one specific application, Aero Supply has established capability in this area and is prepared to design and manufacture other 400 cycle non-rectified solenoids valves to meet your specification. Request Bulletin #59-130 and our Capabilities Report.

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proper required electrical charge either while it is in its storage tank, at the manifold, or in the injector face area, since it operates a considerably lower temperature level than the 1,500 deg. Kelvin which are required for ion propulsion systems.

Approximately 90% of the system weight is involved in the reactor. Engineering effort is required to bring the system to its best operating design configuration, concurrently with work in colloid development, Lee said.

Extrapolated data shows an improved thrust/weight ratio for the colloid system over ion propulsion, Lee said. In addition, a better over-all system mass ratio is obtained using colloids that it is possible to obtain with ion propulsion.

ARPA Contracts

Washington—Following is a list of projects funded by the Advanced Research Projects Agency as of April 30, 1959. Contracts are listed in the following manner: Description of work, participating government agency, principal contracts awarded or being negotiated and estimated project funding by ARPA through Fiscal 1959.

CIVILIAN SPACE PROGRAMS TRANSFERRED TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION:

Two lunar probes, cosmic ray experiment and 12 ft. sphere, Army Ordnance Missile Command, transferred to NASA, $18,820,000; three lunar probes, Air Research and Development Command, transferred to NASA, $7.6 million; ground scanning for lunar probes, Naval Ordnance Test Station, transferred to NASA, $400,000; meteorological payload, Army Signal Corps, Radio Corp. of America, $6,711,000.

Total: $33,531,000.

MILITARY SPACE TECHNOLOGY SATELLITE SYSTEMS:

Discoverer, Secretary of the Air Force, Lockheed Aircraft Corp., $106 million; Midas, Air Research and Development Command, Lockheed Aircraft Corp., $10.8 million; Score, Air Research and Development Command and Army Signal Corps, Convair Division, General Dynamics Corp., $704,000; Sentry, Secretary of the Air Force, Lockheed Aircraft Corp., $96.6 million; delayed repeater system (Courier), Army Signal Corps, (primarily in-house), $3 million; doppler navigation system (Transit), U. S. Navy Bureau of Ordnance, Johns Hopkins Laboratory and Lockheed Aircraft Corp., $1,383,000; subsystems for meteorological project, Air Research and Development Command, no contractors listed, $1,151,000.

Launch vehicles, Air Research and Development Command, Douglas Aircraft Co., Inc., $18.3 million; active repeater communication satellite (launch and control), Air Research and Development Command, no contractors listed, $1 million; active repeater communication satellite (payload), Army Signal Corps, no contractors listed, $1 million.

PROPULSION AND LAUNCH FACILITIES.

Saturn, Army Ordnance Missile Command, in house with engines from Rocketdyne Division, North American Aviation, Inc., $24,508,000; Centaur, Air Research and Development Command, Convair Division, General Dynamics Corp., and Pratt & Whitney Division, United Aircraft Corp., $16 million; static test tower and launch stand construction (Saturn), Army Ordnance Missile Command, no contractors listed, $9,492,000; large thrust test stand, EAFB (one-million

pound thrust single chamber engine), Air Research and Development Command, no contractors listed, $240,000.

Total: $239,938,000.

BALLISTIC MISSILE DEFENSE (PROJECT DEFENDER).

Information center on high altitude weapons effects, Air Research and Development Command, the Rand Corp., $144,000; reentry physics studies, Air Research and Development Command, Massachusetts Institute of Technology, $4,646,000; omnirange digital radar, Air Research and Development Command, Columbia University, $1,328,000; electronically steerable array radar, Air Research and Development Command, Bendix Aviation Corp., $2,144,000.

Missile range measurements, Air Research and Development Command, (primarily in-house), $3,435,000; Acania assignment to AMTR, Air Research and Development Command, Stamford Research Institute, $575,000; high frequency ionospheric radar research, Office of Naval Research, (primarily in-house), $535,000; ballistic missile defense system studies, Air Research and Development Command, Convair Division, General Dynamics Corp., $1,375,000; atmospheric and ionization studies, Air Research and Development Command, A. D. Little Co. and Convair Division, General Dynamics Corp., $1,435,000; radar discrimination, Air Research and Development Command, Raytheon Manufacturing Corp., $680,000; downrange ship operation, Army Ordnance Missile Command, Radio Corp. of America, $2.7 million.

High power radar research, Army Ordnance Missile Command, Cornell Aeronautical Laboratory, $1,361,000; advanced radar research, Air Research and Development Command, Lincoln Laboratory of Massachusetts Institute of Technology, $515,000; vertical probe launching, Air Research and Development Command, (in-house), $397,000; decoy sorting radar, Air Research and Development Command, Raytheon Manufacturing Corp., $1,180,000; microwave radar, Air Research and Development Command, Radio Corp. of America, $850,000; artificial electron clouds study, Army Signal Corps., Itek Corp., $30,000.

Catalytic effects in discharges, U. S. Army Ballistic Research Laboratory (Aberdeen Proving Ground), (in-house), $86,000; design of hypersonic intercept system, Air Research and Development Command, Convair Division, General Dynamics Corp., $1,033,000; hypervelocity impact research, Naval Research Laboratory, (in-house), $525,000; hypervelocity impact research, U. S. Army Ballistic Research Laboratory (Aberdeen Proving Ground), (in-house), $300,000; photodetachment cross-section studies, U. S. Department of Commerce, National Bureau of Standards, (in-house), $30,000; digital phased array radar, Army Ordnance Missile Command, Sylvania Electric Products, Inc., $1,434,000.

Transmission of ion and atomic beam studies, Army Signal Corps, American Machine & Foundry Co., $100,000; feasibility studies (primarily GLIPAR), Office of Naval Research, General Atomic Division, General Dynamics Corp., Stanford Research Institute, Westinghouse Electric Corp., Aeronutronic Systems, Inc., Allied Research Associates, University of Chicago, Convair Division, General Dynamics Corp., General Electric Tempo, General Mills, Inc., Hughes Aircraft Co., Industrial Research Associates, Thompson Ramo Wooldridge, Inc., Radio Corp. of America, Republic Aviation Corp., and Technical Operations, Inc., $1,780,000.

Feasibility studies (satellite defense systems, missile phenomenology), Air Research and Development Command, Radio Corp. of America, Convair Division, General Dynamics Corp., General Electric Co., Lockheed Aircraft Corp., General Atomic Division, General Dynamics Corp., Republic Aviation Corp., Dikewood Corp., and Allied Research Associates, $3,805,000; feasibility studies (space intercept, re-entry and target studies), Army Ordnance Missile Command, Solar Aircraft Corp., Bendix Aviation Corp., Avco Research Laboratory of Avco Manufacturing Corp., Raytheon Manufacturing Corp., Convair Division, General Dynamics Corp., $3,257,000.

Total: $35,683,000.

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Among the many quality components that help assure dependable, safe operation of the Lockheed Prop Jet Electra is the oil cooler flap actuator produced by Airborne Accessories Corporation, Hillside 5, New Jersey. Because dependability is a must, Airborne uses KLIXON Protectors to guard motors against excessive temperatures.

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"We use KLIXON *Protectors exclusively on our motors used on actuators for military and commercial aircraft as well as for missiles. We have found from experience that close cooperation between the motor designer and the motor protector supplier is one of the keys to reliable motor performance."*

For more information, write for new catalog KLIXON Inherent Overheat Protectors for High Performance Motors.

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. . . when life or property stand in danger under the shadow of a suddenly errant missile – the human finger poised over the "Destruct" button moves quickly downward, on information supplied by Cubic Corporation's Bi-COTAR.

Beneath the finger of the Range Safety Officer are buttons that will destroy the missile in flight or cut off its fuel supply. The RSO's precise knowledge of trajectory and impact prediction is furnished by a Bi-COTAR, which is the major range safety equipment for the West Coast's first ballistic-missile base.

From two tracking sites at Vandenberg Air Force Base, like two searchlights with their beams intersecting on the missile, Bi-COTAR derives direction information from standard telemetry signals. At the Instrument Control Center precise trajectories and predicted impact points are plotted for the Range Safety Officer . . . his guide to decision.

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USAF Aware of Industry Unrest Over Weapons Study Procedures

Los Angeles—Air Force awareness of industry's privately expressed dissatisfaction with the study requirement method of establishing the feasibility of new weapon systems was brought to light by Dr. Joseph V. Charyk, assistant secretary of the Air Force, research and development, at the Institute of the Aeronautical Sciences meeting here.

"Substantial financial and technical talents are brought to bear on systems studies and the Air Force ultimately receives competitive proposals from teams composed frequently of many major companies, he said. "We are of course, interested in the case of each weapon system, in finding the best technical approach and exploiting the best possible talents to produce the optimum system at the lowest cost to the American taxpayer. We cannot afford to be bound by the rigidity of specific approaches with given combinations of industrial companies. We respect and appreciate the circumstances that lead to the problem and we recognize fully the effort and the resources that go into such a joint enterprise. I have no simple solution to suggest, but it is a matter that will continue to receive urgent and careful study."

Industry Role

Dr. Charyk commended the aircraft industry for its role in providing America's deterrent power. Aircraft of the Strategic Air Command which comprises some 400 Boeing B-52s, some 1,400 Boeing B-47s and nearly 1,000 tankers have been responsible for keeping the balance of power in favor of the United States.

Future strategic weapons to maintain this balance were listed by him as the supersonic Convair B-58, the Northrop Snark intercontinental missile and the intercontinental ballistic missile family.

However, he pointed out that none of these weapons can be effective as a retaliatory force unless our air defense methods can guarantee them against destruction by a surprise attack. The present air defense complex consists of manned interceptors like the Convair F-102 and F-106, point defense missiles of the Douglas Nike Hercules type and area defense missiles of the Boeing Bomarc type, he said. Ballistic Missile Early Warning System, which will ensure at least 15 min. warning of an ICBM attack, is rapidly being constructed. One site is proceeding rapidly and another is beginning, he said. Midas, a satellite for an infrared early warning system which detects radiation emanations from booster rockets, will offer the near maximum warning time possible against ballistic missile attack.

Dr. Charyk also said that one ruble spent by the Russians to sophisticate their offense may be matched by many hundreds of dollars in defensive measures.

He told the IAS that this was a real challenge and said, "I sincerely feel that the solution will require a departure from conventional thinking."

Simulating Lunar Landings

Flight simulation of lunar landings at altitudes beyond the earth's atmosphere using a rocket-powered capsule was proposed by Norman V. Petersen of Northrop Corp. He outlined general requirements for a safe, low-cost experimental flight test program offering approximate simulation of lunar landing flight dynamics.

The program would use the earth's atmosphere as an air cushion for recovery of maneuverable rocket-powered manned capsules in simulated landing trajectories. Petersen noted suggestions for the use of ground-based simulators for early training of space crewmen prior to the first manned orbital attempts and observed that the same methods could be used for early-phase training of lunar crews.

Lunar landing trajectories would generally be practiced above the atmosphere at near-zero drag conditions. Aerodynamic drag would permit recovery of a lunar landing simulator in event of a malfunction. A balloon-launched rocket powered capsule may also prove to be useful. With it, vertical rocket trajectories could be practiced with a subsequent free-fall into atmospheric re-entry.

Power from a small rocket would bring the vehicle to zero velocity at some pre-established altitude. Only about 10% of the energy of the braking maneuver is actually defrayed by the braking rocket in the simulator. Re-entry drag would provide as much as 90% of the total. A variable drag skirt

Chanute Award

John P. Reeder, chief research pilot for the National Aeronautics and Space Administration at Langley Field, Va., was presented the Octave Chanute award for notable contribution to aeronautics as a pilot.

Reeder was cited by IAS President William Littlewood for his contribution in stability and control testing and instrument flying research in helicopters.

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might further modify the re-entry trajectory in order to better simulate actual braking rocket acceleration-time characteristics. As the vehicle becomes subsonic during re-entry, the braking rocket would be fired to give precise altitude control. Terminal phase requires operation of the braking rocket while the vehicle is moving backward within the atmosphere. Guided missiles have been controlled satisfactorily during such reversed flight. Control system would have to include an on-board computer to solve the braking rocket maneuver and assure a propellant reserve on landing.

It should also include a pilot-override feature to permit precise control for the simulated touchdown at a specified altitude. Main propulsion system should be throttable and presumably would use a bi-propellant combination. High specific impulse is not essential since only partial simulation is required. If hydrogen peroxide and RP-1 were used for the fuel in the main propulsion system, the peroxide could also be used for reaction control jets. Although it would be possible to see the earth's surface from an altitude of 50 mi., it would probably be useful to employ a film display showing lunar terrain features associated with the specific landing operation. An error programed in the guidance system would allow the pilot to practice use of the override feature in making a precise landing. Petersen said the lunar landing problem is complex and that a reasonably long lead time will be needed, but current flight test programs in support of Project Mercury will provide sufficient flight experience and technical capability to permit establishment of a lunar flight test program at an early date.

U. S. Aeronautical Education

Panel discussion on whether or not U.S. aeronautical education is obsolescent was summarized by Chairman Lt. Col. J. H. Polve, associate professor of aerodynamics at the USAF Academy. Panelists were divided equally as to whether the educational program should be vastly revised or merely improved in its present form.

There is still a need, said Prof. John D. Akerman, of the University of Minnesota, for our present form of aeronautical education providing the curricula are revised and updated. He did not agree with other panelists who wanted aerodynamics oriented more toward astronautics. In his argument for continuing present aeronautical courses Akerman said, "we need a transport which can land in the space of less than one county and that is inexpensive enough for people who are not on expense accounts to afford."

An opposite view was taken by Lt Col. L. H. Levine of the Army Ordnance Missile Command, who said new graduates come to the Army with only a potential. Only after three years, starting from the drafting board, are they considered to be in the professional classification of aeronautical engineer. He recommended increasing university courses from four to five years with greater emphasis on astronautics to include celestial mechanics, astrophysics, and associated subjects.

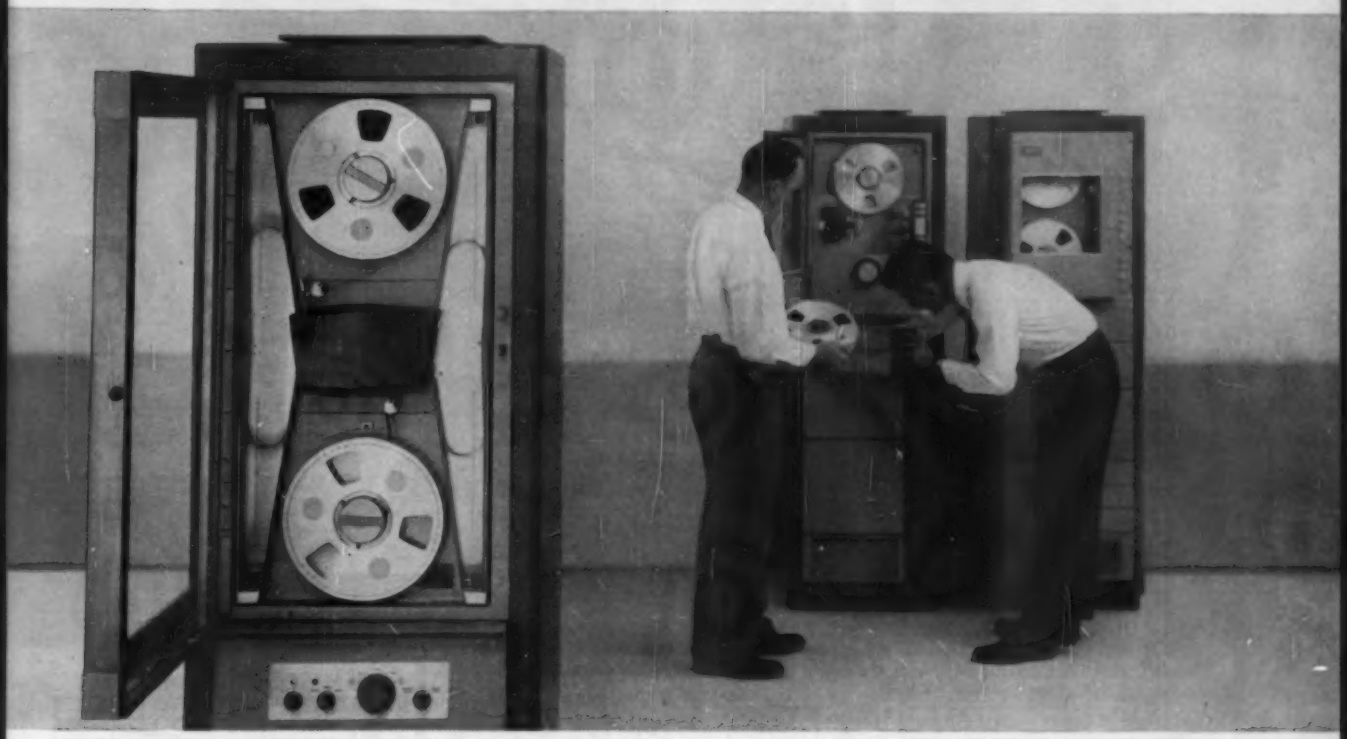
Dr. Leon Trilling, Massachusetts Institute of Technology, told the IAS that total higher education enrollment in Soviet Russia is in the neighborhood of two million students, of whom 1,200,000 are full time. In 1958, Russian universities graduated 290,000 students; approximately two-thirds of these were in natural sciences and engineering. Women account for about half the total enrollment and about 35% of the engineering enrollment.

Aeronautical engineering students in Russia number 25,500 in eight universities, and about 3,200 are graduated each year. By contrast, U.S. universities have 10,000 undergraduates of which approximately 1,000 graduate each year. All Russian graduates, however, do not become practicing engineers; some go into management. The U.S. practice is to specialize in management courses. These statistics, brought out by Dr. Trilling, are the result of a study he has made as an avocation of the Soviet educational system.

Age distribution of practicing aeronautical engineering graduates shows that the United States is ahead of Russia in the number of aeronautical engineers between the ages of 33 and 43. Dr. Trilling considers engineers in this age bracket as "seasoned" and the ones who are of most benefit to the U.S. aircraft industry. Conversely, the Russians have 3½ times as many aeronautical engineers in the 25-year age bracket. He concludes from this that in 10 years Russia will have approximately three times as many seasoned aeronautical engineers as we have in the United States. He said, "if you think the Russians are good now, wait until 10 years from now."

Projecting 10 years further into the future, Trilling predicted that the United States would regain the advantage in the number of seasoned engineers because of the strenuous drain on Russia's manpower and birth rate during World War II. He said enrollments in secondary schools is off sharply compared with U.S. schools. He said the U.S. experienced a "bumper crop" of births during the war years which is in direct contrast to the sharp decline of Russia's birthrate.

A five-foot bookshelf is a 10-minute task



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Yes, the Ampex FR-300 could easily "read" or "write" the digitalized equivalent of a five-foot bookshelf in less than ten minutes. Why is this important? Because today's big computers accept and present large quantities of data in a hurry. Their time may be worth as much as $1000 per hour. Keeping one waiting for data is expensive.

As the fastest available magnetic tape handler for "on-line" duty with these machines, the FR-300 maximizes utilization of high-speed digital computers. By placing two 6-bit alpha-numeric characters side by side on one-inch tape at 150 ips and 300 bits per inch, it achieves 90,000 character-per-second transfer rates.

Short, predictable start/stop times reduce buffer requirements and Ampex dependability further increases computer efficiency.

Ampex offers digital systems complete from head to tape (the sensational new Ampex Computer Tape, by the way) because a system designed as an integrated whole will out-perform those built from tape transports, magnetic heads, amplifiers and tape secured from a variety of different suppliers.

For lesser computers and "off-line" duty on such auxiliary digital equipment as converters, data plotters, printers, etc., the FR-400 and FR-200A tape handlers (not shown) provide a wide wide range of lower transfer rates. And in the background above are two fine analog recorders, the FR-100A and FR-1100, to remind you that only Ampex offers such a broad line of fixed and mobile recorders for instrumentation and control.

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The airframe: A Convair 340/440, the same airframe which has proved itself in millions of miles of airline service on both main and feeder routes, plus thousands of hours with these same Allison Prop-Jet engines and Aeroproducts propellers.

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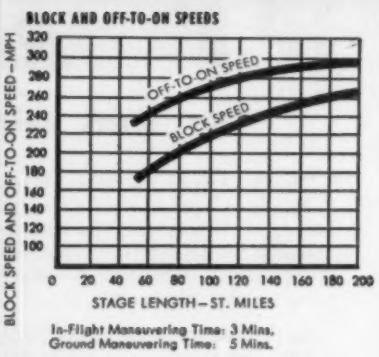

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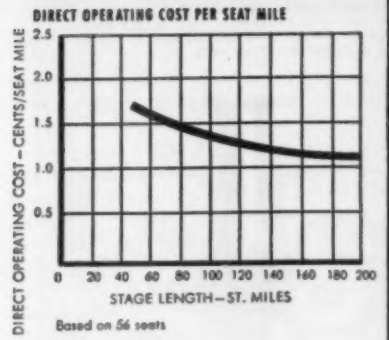
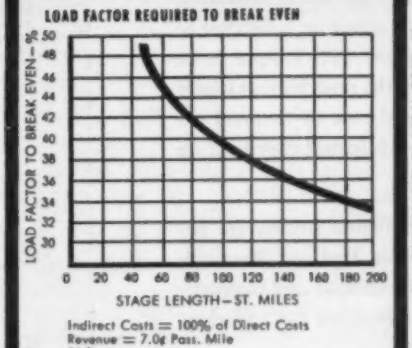
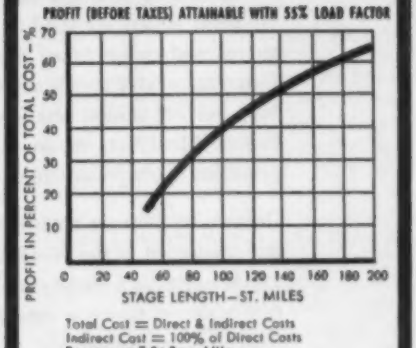


Based on 56 seats



Indirect Costs = 100% of Direct Costs
Revenue = 7.0¢ Pass. Mile
56 Seats
No Cargo Revenue



Total Cost = Direct & Indirect Costs
Indirect Cost = 100% of Direct Costs
Revenue = 7.0¢ Pass. Mile
56 Seats
No Cargo Revenue

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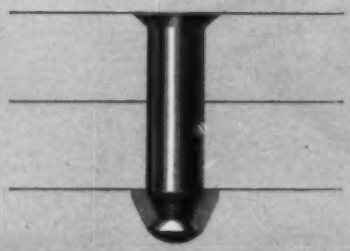
Continuing fastener environmental studies are being conducted at the Hi-Shear Test and Research Laboratories in a variety of strength and temperature resistant material combinations for advanced structural requirements.



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AVIONICS

El Al to Use In-Flight Phone Service

By Philip J. Klass

Washington—Within 30 days, El Al Israel Airlines passengers will be able to make radio-telephone calls to almost any part of the world while in flight along the airline's international routes. Passengers also will be able to send and receive telegrams while en route.

International air-ground radio-telephone service, which has been undergoing experimental trials for some months, recently went into operational service for El Al flight crews, enabling them to make direct telephone contact with the airline's ground staff for emergency operational or weather information.

The new service is expected to prove extremely popular with international travelers, as it has with domestic passengers in the Midwest where Northwest Airlines and American Telephone & Telegraph Co. are conducting an air-ground radio-telephone evaluation on a limited basis (AW Jan. 27, 1958, p. 90). First passenger to try the new service was the Queen of Belgium who recently phoned the Royal Palace while en route from Tel Aviv to Brussels.

Cost of a three-minute telephone call from over the Atlantic to New York City is expected to be about six to nine dollars, depending upon airplane location at the time. Steward will collect for the call upon completion, based on charges computed by the maritime coastal radio station which provides the link between the airplane and the domestic telephone system. There are several dozen such maritime stations around the globe.

To achieve the long range required for transocean communications, El Al uses high frequency (HF) radio which inherently is subject to more propagation problems than the ultra-high frequency (UHF) employed for short-range domestic radio-telephone service. However, a call received by this Aviation Week editor from Joseph Rosenberg, El Al's superintendent of communications, aboard a Bristol Britannia in mid-Atlantic, came through loud and clear with excellent intelligibility.

The service will become available to El Al's regular passengers starting next month when two new features have been added for passenger convenience:

• **Voice-sensitive switch** (Vox), which will switch on the transmitter when passenger speaks, switch back to receiver when he stops for more than a brief interval. At present, it is necessary to push a button on the airborne handset to talk, release it to listen.

• **Speech scrambler** to provide privacy in communications. Device which El Al will use, made by Westrex Division of Litton Industries, automatically inverts human voice frequencies, relative to a 1,500 cps. standard, prior to transmission. Device also serves to unscramble shore-to-air messages.

EL AL AIRLINES' air-ground radio-telephone service will enable passengers to communicate, while in flight over the Atlantic or along the airline's routes, with almost any city on earth. The service also will be used by the flight crew to make direct telephone contact with the airline ground staff members at their homes or offices.

Placing Call

Placing an international call via the maritime stations is a little more involved than the domestic U. S. air-ground radio-telephone service because not all of the maritime stations maintain a continuous 24-hr. watch on voice channels.

The surest procedure is for the aircraft to send a radio-telegram in advance to the specific maritime station which will provide contact. The aircraft requests service at a designated time, giving radio frequencies to be used and the airplane's approximate location at the time of contact.

At the designated time, the airplane calls the maritime station. If propagation conditions permit a "commercial quality" contact, the call is routed to switchboard operator who then places it to the intended recipient much like a conventional telephone call.

However, it is permissible and frequently possible for aircraft to contact the station without prior notification, Rosenberg points out, by calling on one of the frequencies listed for the station which is under continuous monitoring.

Radio-telephone messages from the ground for airborne passengers are listed by maritime stations during regular hourly roll-call so that passenger can be ready to receive call at appointed time.

When El Al first discussed the possibility of international radio-telephone service to in-flight aircraft, there were some doubts whether it would prove feasible because of the relatively low-power transmitter aboard the airplane.

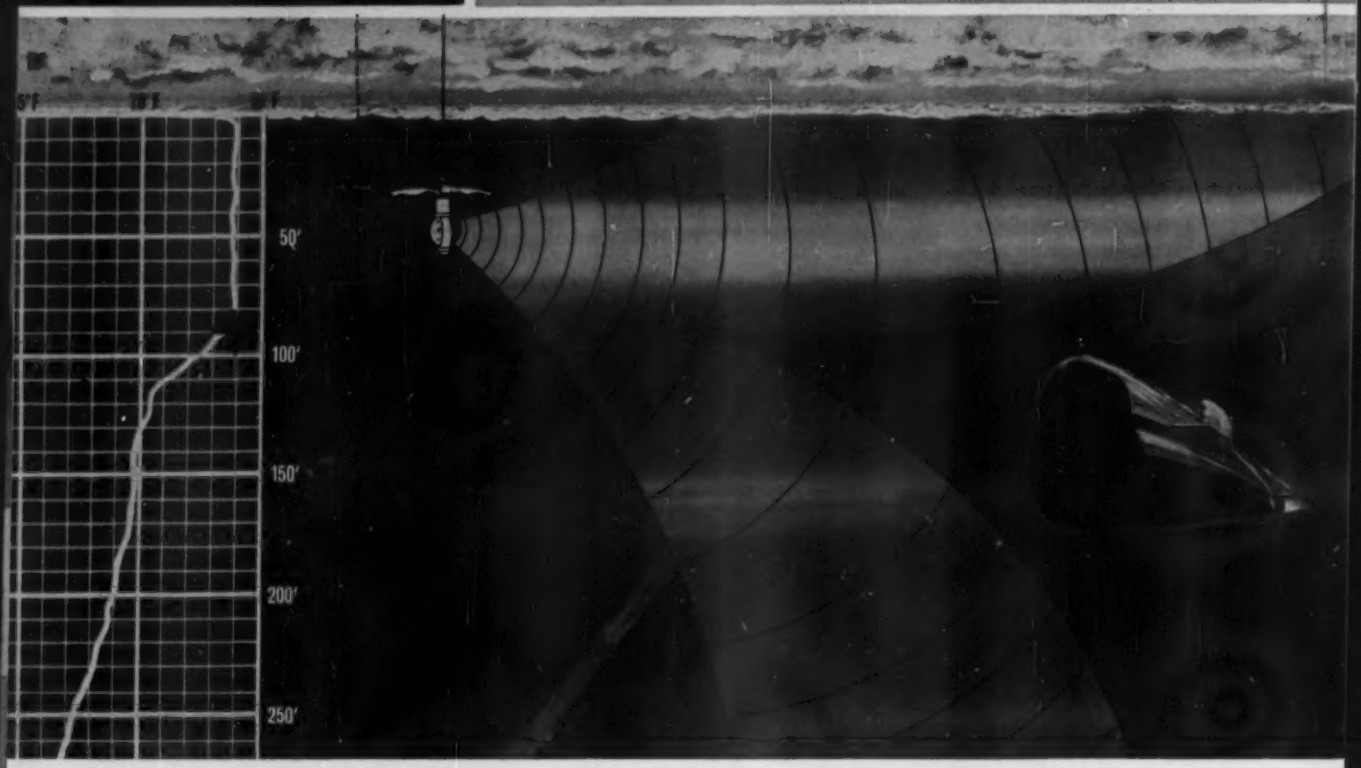
However, encouraged by AT&T engineers, the airline began a series of tests using Station WOO at Oceangate, N. Y. (Two other U. S. stations are WOM in Miami and KMI in Oakland, Calif.) First successful call was made late last year from an airplane near Greenland to New York City. Tests showed that commercial quality service was feasible, but that there were a few problems that first had to be overcome, Rosenberg says.

For example, because there is no maritime traffic in the very northerly portions of the Atlantic, Station WOO had no antennas oriented to cover this area which often is used by westbound

idea:

Submarines can hide within range of helicopter-borne sonar by "riding the thermocline"—a water temperature change that casts shadows in sonar search patterns. Precise temperature-vs.-depth records allow the operator to spot thermoclines and change his search pattern to look into the shadows. Existing gear "worked", but it took too long and could not define the shadow zones very accurately. TI engineers created an automatic recorder, the **bathythermograph,** more accurate than a laboratory thermometer, that gives results instantly where they were needed—in the helicopter. Small as a portable typewriter, it easily fits with the sonar into the space available.

RESULT: Same sonar—fewer missed submarines.



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transatlantic flights. This made radio contact difficult when aircraft were flying the very northerly routes. The station is now taking action to provide suitable antennas to cover the area.

Despite these early problems, the airline conducted successful tests using maritime stations in the U. S., United Kingdom, Holland, Italy and Israel. On one occasion, an airplane in mid-Atlantic talked to company offices in New York, London, Amsterdam and Tel Aviv in a period of 30 min., using a Dutch coast station at Scheveningen as a relay, Rosenberg says.

The ability to tie into telephone and cable circuits directly is expected to become a valuable operational aid for El Al flight crews. For example, in event of a mechanical difficulty with an airplane in mid-Atlantic, the captain or flight engineer can talk directly with a member of the airline's ground staff at his home or in his office.

For the new international radio-telephone service, El Al uses one of two 100-w. HF transmitters it carries aboard its aircraft. The other normally is used for air traffic control communications. The equipment, which provides 100 crystal controlled channels in the 2.8 to 18 mc. band, is made by Standard Telephones & Cables, Ltd. of Britain.

With maritime stations switching over to single sideband operation to obtain improved intelligibility and increase channels, Rosenberg expects that El Al may eventually equip its aircraft with single sideband equipment. If air-ground radio-telephone develops as expected, the increased maritime station channels will be put to good use.

El Al's Chief Radio Officer Daniel Alon and R. F. Bloom of Station WOO made major contributions to the development of the new service, in addition to Rosenberg. Personnel at British, Dutch and Israeli maritime stations also provided helpful assistance, Rosenberg adds.

Data Transmitting System Proposed

High-volume, high-speed weather information distribution system based on the old-fashioned principle of the telephone party-line has been proposed to the Summer and Pacific General Meeting of the American Institute of Electrical Engineers by E. E. Schenzfeger of Bell Telephone Laboratories.

The system is said to transmit messages and weather data at the rate of 1,000 words per minute with 1,000 stations transmitting and 5,000 receiving. Because of its speed and because only useful information is received by a receiving station, the system is said to be a 20-fold improvement over the existing system.

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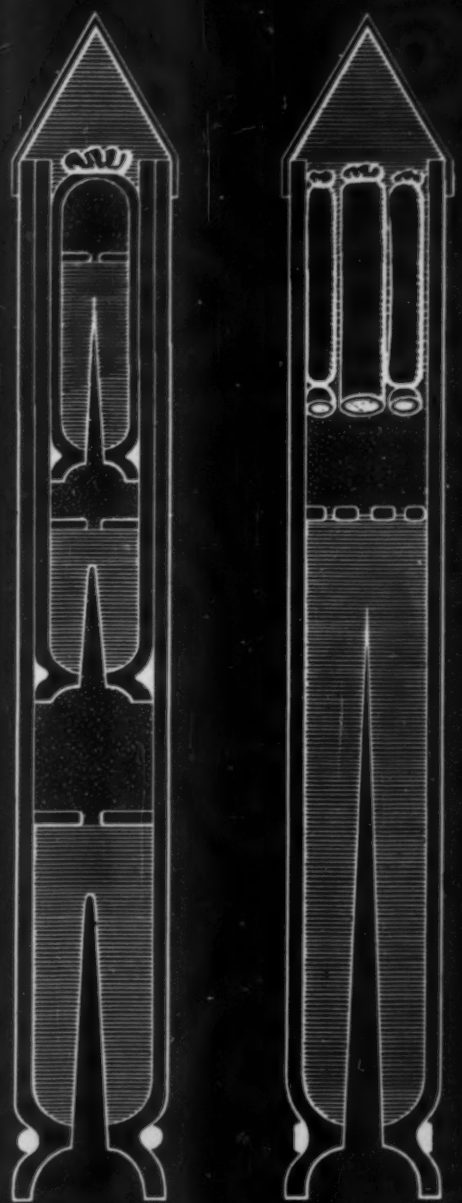
FLIGHT SCIENCES



FLIGHT SCIENCES. Principle of the step or multi-stage rocket, considered fundamental to the art of modern missiles and space flight, was set forth as long ago as 1650 by Kazimierz Siemienowicz, lieutenant-general of ordnance to the king of Poland. His design featured a 3-stage rocket with each step having its own gunpowder fuel, fuse, and nozzle.

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Pioneering work at Lockheed is being conducted in free molecular flow, in orbital flight, high altitude atmospheric properties; trajectory studies and missile flight dynamics; celestial mechanics with emphasis on orbital tracking predictions and de-orbiting.

Lockheed's capabilities in gas dynamics and thermodynamics are unsurpassed in private industry. Basic work is being performed in boundary layer flow and heat transfer; cooling and insulation; thermodynamic flight test; instrumentation; rocket motor controls and nozzle structures; reentry and materials; thin film thermometry; and measurements of dissociation and re-combination reactions.

Fundamental studies include hypersonic aerodynamics; environmental effects on satellite surfaces; magnetohydrodynamics; ultra-violet and infrared radiation from high temperature air flows; structure of hypersonic shock waves; new measurement methods; analysis of boundary layers near melting surfaces and study of lag or non-equilibrium in high speed flow through shock waves.

Equipment includes an electrically-driven wind tunnel—fastest in industry—which produces airflows to Mach 20-plus and stagnant temperatures approaching 16,000° F, with an instantaneous power output of 20 million kilowatts. A spark-heated, magnetically driven research shock tube produces velocities of over Mach 250 and temperatures of 500,000° F, and a specially designed, electric gun has accelerated projectiles to speeds approaching 20,000 ft/sec.

Major emphasis in structures concerns the design of reentry bodies, thrust termination and underwater launching devices. The Navy Polaris FBM required the solution of complex structural problems necessitated by the unique launching environment—water.

Other significant work has been accomplished in diversified aspects of aerodynamic and hydrodynamic load distribution, aeroelastic effects, studies of special dynamic problems arising from aerodynamic disturbances, cavitation, launching conditions and thermal problems relating to analysis of a complex structure taken through a complete time-temperature environment.

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VISUAL Integrated Presentation uses electro-optical techniques to combine direct view of terrain below and ahead of aircraft or space vehicle with display of radar, infrared, navigation and weapons delivery information. Display was developed by Chicago Aerial Industries.

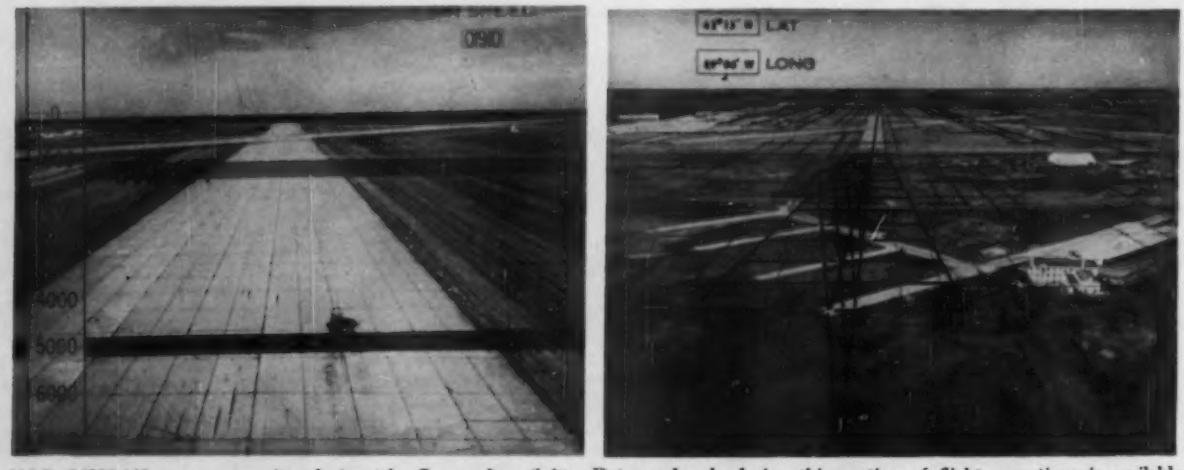
Pilot Display Integrates Data, Terrain

Dayton, Ohio—An electro-optical integrated cockpit presentation in color which gives a pilot any desired combination of visual contact, radar, infrared, weapons delivery, navigation, takeoff and landing information on a single large display, was unveiled here during the National Aeronautical Electronics Conference (NAECON).

Developed by Chicago Aerial Industries, the display is undergoing initial evaluation by Wright Air Development Center's Flight Control Laboratory. The display, known as Visual Integrated Presentation or V.I.P. for short, could find application in extremely high-speed aircraft, orbital and space vehicles, with limited or no cockpit visibility.

With its single multiple-information display, V.I.P. bears some resemblance to the advanced Army-Navy Integrated Presentation (ANIP) (AW Aug. 11, p. 48). A significant difference is that V.I.P. does the job by electro-optical means instead of requiring flat cathode ray tubes which still are in development and which require considerably more complex accessory equipment. Another advantage is that V.I.P. can display terrain or navigation maps in color.

The new V.I.P. is an extension of the techniques employed in the aerial viewfinder periscope which Chicago



V.I.P. DISPLAY serves as monitor during takeoff procedure (left). Data used only during this portion of flight operations is available without use of instrument panel area at other times. On landing approach the ground contact analog grid provides simulation of aircraft attitude (right), with visual ILS localizer and glide path indication leading to the runway threshold.

Aerial Industries builds for the McDonnell RF-101 and Chance Vought F8U-1P to give the pilot a direct look at the ground below or ahead.

With relatively small increase in size, weight and complexity, radar and infrared system information appearing on a cathode ray tube built into V.I.P. can be optically combined and/or superimposed on the visual picture of the terrain. For example, by combining infrared and visual, pilot can see "hot targets" such as powerplants and factories. Navigation maps can be shown on half the display alongside a visual picture of the ground below for side-by-side correlation.

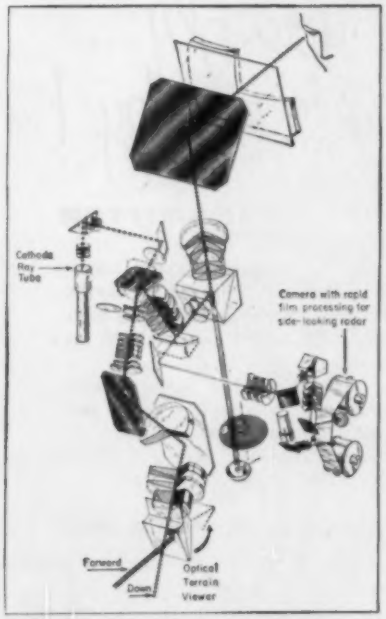
The pilot can select and display the information he wants for any particular phase of the mission. By presenting information from a variety of sources in a single display, the pilot need not scan a variety of individual instruments and refocus his eyes each time to accommodate each display.

Multiple Functions

Here are some of the functions which can be displayed on Visual Integrated Presentation, according to Chicago Aerial Industries:

• **Takeoff:** Takeoff monitor information on distance to point of refusal and lift-off can be superimposed on pilot's view of runway ahead.

• **Climbout:** Airplane attitude information (obtained from horizon gyro) can be superimposed on visual contact view



OPTICAL schematic of Visual Integrated Presentation shows how periscopic view of ground terrain is combined with radar or infrared system information from cathode ray tube, and other data.

Under flexing tests conducted by Wright Air Development Center engineers, this improved ducting showed no damage after 1,000 flexing cycles, 380-390F temperature, and 90-pound-per-minute air flow.

LIKE NEW AFTER 1000 FLEXING CYCLES

THERMOID-QUAKER jet-starter hose has exclusive government approval. Only Quaker jet-starter hose has government approval for use in starting jet engines. This new "Dacron"-and-silicone rubber hose is $200 cheaper for each 30-foot length. Yet it extends the life of pneumatic ducting from 200 to 5,000 engine starts.

It won't kink, because of cross-braid construction. Threads are crossed at right angles to one another to distribute the load in all directions. A scuff cover of porous netting is bonded at 2½-inch intervals to doughnut-like silicone scuffers.

Get complete information, including Technical Data, on Quaker jet-starter hose, from your local Thermoid industrial distributor, or write *Thermoid Division, H. K. Porter Company, Inc., Tacony & Comly Sts., Philadelphia 24, Pa.*

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This transmitter is recommended for use with ARC's line of tunable receivers, (R-13B and R-19) for a primary communication system on small aircraft or as a "back-up" to ARC Type 210 Transmitter-Receiver on larger aircraft.

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of ground or airspace ahead, with angle of attack and/or airspeed also shown along one edge of the display.

- **En route navigation:** During en route phase, pilot can select a direct visual contact display, a radar ground mapping display, a navigation map, or combination of these.
- **Target identification:** Infrared system information on hot targets can be superimposed on either a visual or radar display.
- **Weapon delivery:** Bombing computer information on aircraft aiming point can be superimposed on visual or radar display.
- **Approach and landing:** Position of localizer and glide-path beams, graphically displayed, can be superimposed on the visual contact picture, with airspeed and/or angle of attack displayed along one edge.

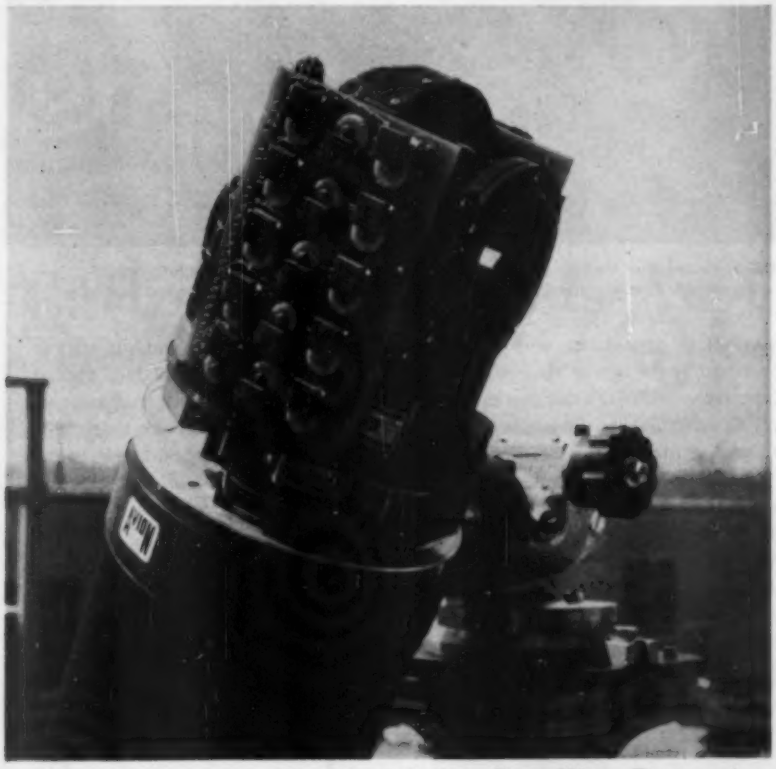
Display Realism

The cockpit model which Chicago Aerial Industries has built to demonstrate V.I.P. uses a flat plastic fresnel lens which provides an 11 x 13 in. display, collimated to make the image appear at infinity. This allows a modest amount of pilot head movement without loss or apparent shift of the image. A company spokesman says the newly developed flat plastic lens is the largest of its type, providing a display of sufficient size to give the illusion of a direct view out a window in the nose of the vehicle.

The Visual Integrated Presentation optics can be designed to provide a pilot with a choice of two or more ground viewing angles, ranging from directly down to one looking forward. Field of view can be approximately 80 deg. in azimuth and elevation.

Weight of a Visual Integrated Presentation display is estimated at 50 to 350 lb., depending upon the number of different presentations required and the degree of sophistication desired. For example, if the airplane carries side-looking radar, where only a single line-scan can be observed at one instant, a camera with high-speed film processing may be included to integrate individual lines into a usable picture which can then be displayed on the V.I.P. presentation.

With cockpit visibility and instrumentation becoming a more serious problem on newer vehicles, like Dyna-Soar, company officials see a promising future for their integrated electro-optical display techniques.



Infrared Receiver Designed for Satellite Detection

Infrared satellite's detection will be studied by Air Force Cambridge Research Center with 30-cell, multi-channel wide field infrared receiver. Called CODES for Commutating Detection System, receiver was developed by Avion Division of ACF Industries, weighs 15 lb.

extra protection against in-flight engine failure

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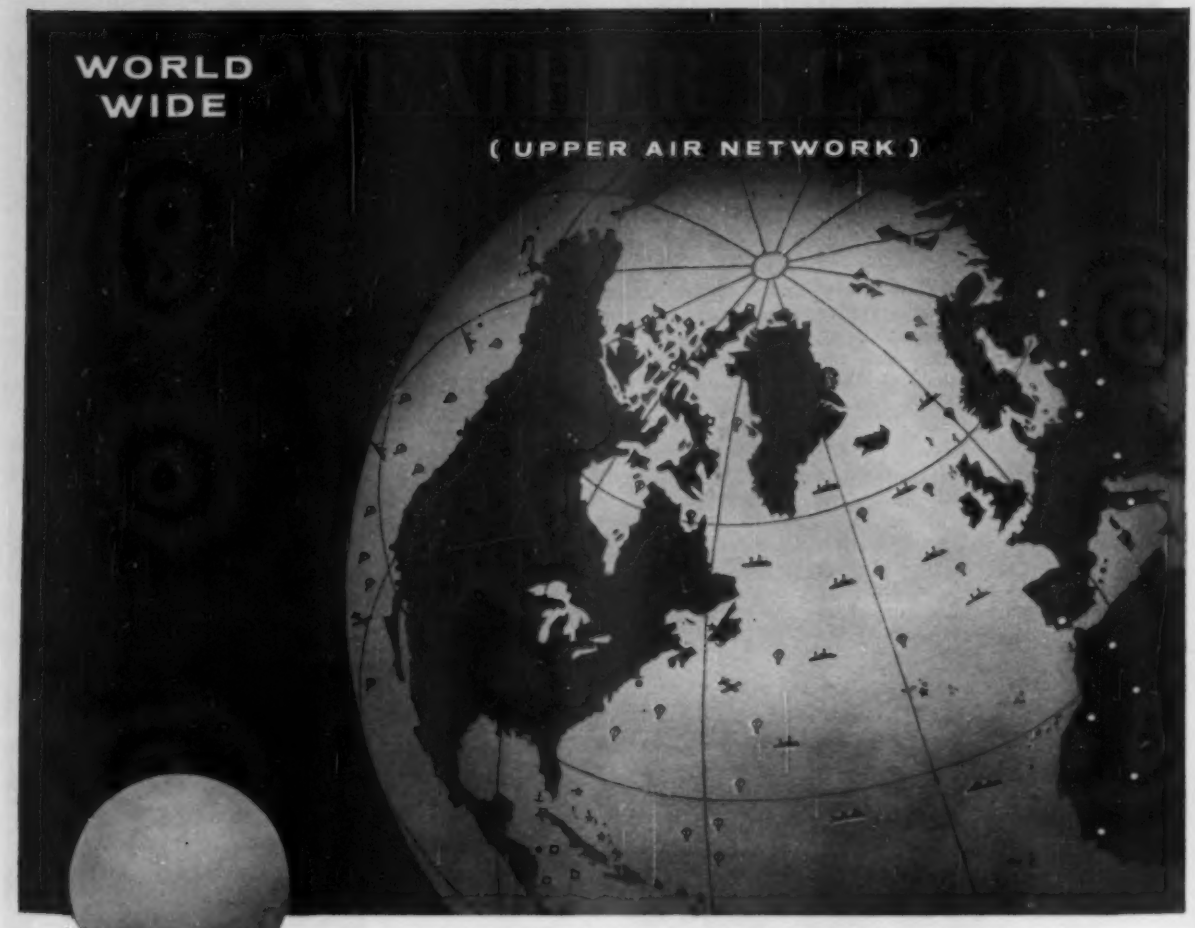
FLY WEATHER-WISE

These weather items prepared in consultation with the United States Weather Bureau



Upper Air Weather Stations dot the world. Observer technicians in all nations report upper air soundings in accordance with international standards and recommended practices.

Each upper air sounding requires carefully calibrated instruments. Large balloons carry Radiosondes up 50,000 feet to 100,000 feet. Radio signals send back information on temperature, humidity, pressure and, in many cases, on wind direction and velocity.

OPERATING in accordance with plans developed by the World Meteorological Organization (WMO) and the International Civil Aviation Organization (ICAO), a vast network of weather stations, generally about 300 miles apart, takes upper air measurements 2 to 4 times daily. Through international cooperation, the results of these measurements are exchanged on a world-wide basis and are made available to the aviation field and the general public.

Upper air soundings are made with balloons carrying RADIOSONDES which report temperature pressure and humidity at various levels. When available, special equipment also permits measurement of the upper winds at the same time. This combination of information allows meteorologists to analyze the complex structure of jet streams, fronts, tropopause surfaces, etc.

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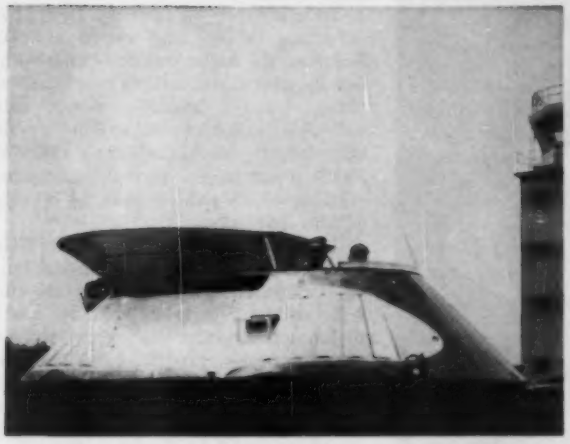
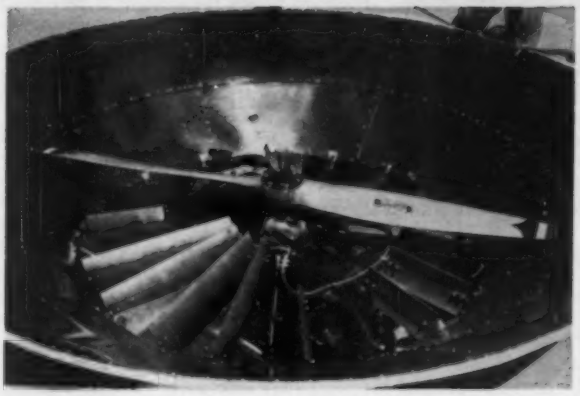




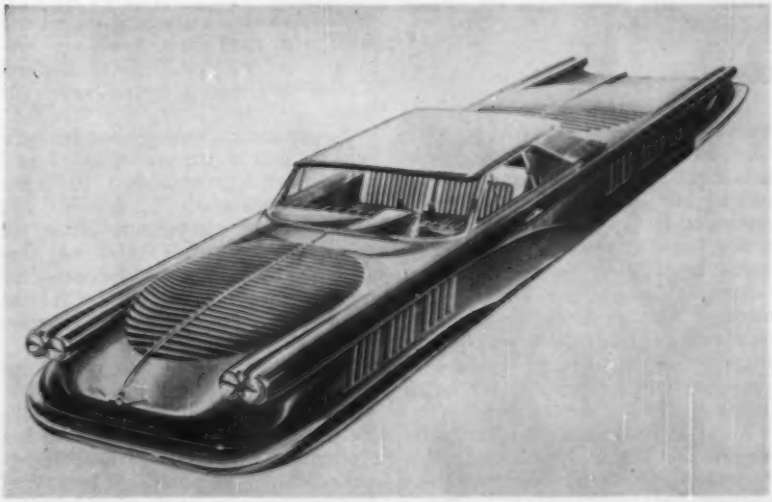
AIR-CAR testbed, which has about 25 hr. "flight" time, hovers an inch off grass (top left). Relatively crude duct of prototype narrows to 5 ft. at throat, has an inefficient fixed pitch two blade propeller. Six bladed fan will replace it. Simple cockpit controls include four levers for louver control and a throttle mounted between the seats.

Curtiss-Wright Tests Air-Car Prototype

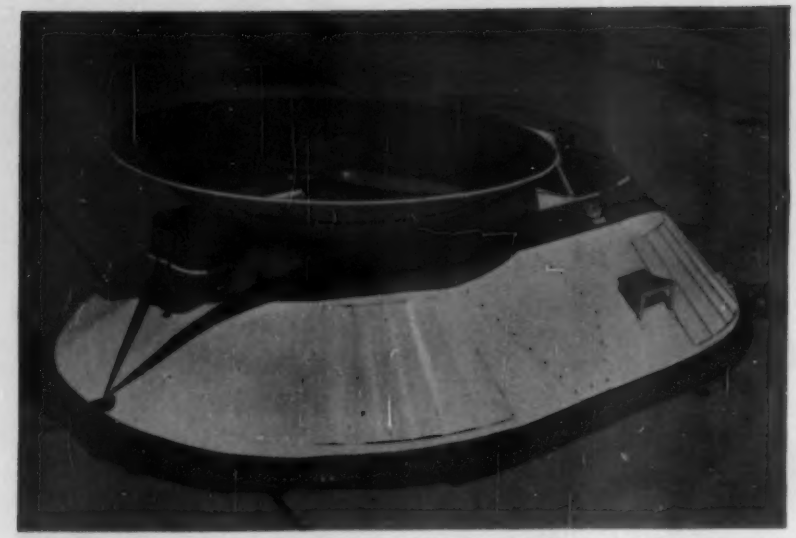
By Erwin J. Bulban

New York—An advanced preproduction configuration of a low-pressure, low-velocity air suspension vehicle that will operate approximately one foot from land or water surfaces and designed for speeds up to 60 mph. is being constructed at Curtiss-Wright Corp.'s Wood-Ridge, N. J., plant and will be rolled out for start of tests in approximately 90 days.

The Curtiss-Wright Air-Car is a four-place twin-engine design having lines closely resembling the 1959 line of U. S. family automobiles, according to company officials. Length will be 28 ft., width 8 ft. Weight will be about 2,800 lb. gross. It will be used as a basic design from which the company expects to develop a family of air suspension vehicles suited to numerous civilian and military transportation require-



FOUR-SEAT AIR-CAR, now being built by Curtiss-Wright, will resemble 1959-model auto.



FRONT and rear louvers are visible on side of Air-Car. Rubber skirt at the base is collapsed with vehicle at rest. External fuel tank is mounted at rear of duct.

ments. Primary purpose is to investigate current unknowns of this novel air cushion principle in performance areas in which the new Air-Car is designed to operate.

A testbed version of the preproduction vehicle is nearing completion and should be ready for tests in the next few weeks.

Curtiss-Wright Vice President Minard W. Stout believes that this stage of the Air-Car's development program should be completed in approximately a year and the vehicle would then be ready for production. This time span will also enable the company to evaluate the market for such a vehicle, he says. Company already is studying a large number of proposals from individuals who say that they would like to buy one now for a variety of off-highway applications including agricultural irrigation missions, as a replacement for swamp and snow buggies.

Government Interest

Interest has been evinced by several military and other government agencies, Curtiss-Wright reports. The company held flight demonstrations for some 30 military and government agency representatives at Caldwell-Wright (N. J.) airport last week of its two-place single-engine testbed. Air Force expressed an interest in the vehicle as a crash-rescue machine; Marines say they foresee a requirement for this type of vehicle, having a five-ton capacity, to replace conventional waterborne craft for beach assault.

Stout indicated that production of the Air-Car would be handled by a current division of the company at one of the present facilities the firm operates in New Jersey.

Behind Curtiss-Wright's interest in developing the air cushion vehicle is some 25-30 hr. of successful testing it has done on the prototype testbed two-place single place Air-Car. Admittedly a crude vehicle, it has served to show the tangible benefits of the air cushion vehicle over conventional surface transportation and the airplane in many applications.

Basic Advantage

Its basic advantages include simplicity of operation, which enables persons with no particular skill to handle the vehicles—Curtiss-Wright operator Vernon Crane says he could teach anyone to handle the Air-Car in a half-hour—simple construction and good load-carrying characteristics.

The approximately 1,000-lb. empty weight Air-Car testbed has lifted approximately 700 lb. thus far in trials with its 85-hp. Continental engine and inefficient fixed-pitch two-blade propeller, and Project Engineer Michael Cutler says this is by no means its limit.

Suspension is accomplished by ducting air into a plenum chamber and maintaining approximately 1/10 lb. psi. pressure underneath the vehicle. The fan raises the air pressure inside the membrane (Air-Car's skin) so that pressure times area of the projected area equals the weight of the vehicle; height above the ground is a function of volume flow through the fan.

Prototype's duct at lip is approximately eight feet in diameter, the propeller is six feet in diameter and the duct narrows to approximately five feet diameter at the neck just below the propeller. Cutler estimates that because of the low efficiency of the two-blade propeller, the testbed is realizing only slightly more than half the power available; next step is to replace the propeller with a six-blade fan having blades of approximately six-inch chord, a 2½:1 reduction gearing and clutch system. Spinning the high-efficiency multi-blade fan at 1,300 rpm. will not only make better use of available power but will also reduce present noise levels considerably. Multi-blade fans will also be incorporated in the preproduction Air-Car, which will be powered by two 180-hp. Lycomings.

The control system now utilizes four levers, two for a set of five vertical louvers mounted on either side on the front of the vehicle and two for a set of louvers on either side of the rear of the machine. Propulsion is accomplished by opening the louvers at front and rear. Moving them forward causes the vehicle to be propelled forward, rearward causes the vehicle to be moved rearward. By operating the louvers differentially, the vehicle will turn on its own axis.

Directional Control

During a demonstration, operator Crane showed good control in forward, rearward and turning movement, both over a concrete ramp and over comparatively flat grassy areas at the airport. Preproduction Air-Car will be fitted with a conventional wheel to handle all directional control. Because of limited power available, the prototype testbed has a ground clearance below the flexible rubber skirt of approximately one inch. When a multi-blade fan is fitted, the testbed is expected to have three or four inches ground clearance below the rudder skirt. Use of a flexible skirt, which acts as a boundary for air flow, permits the vehicle to pass over low obstacles.

Current design will permit the Air-Car to climb grades up to 6%. The company anticipates that purchasers will have an option of having either aviation-type or standard automotive-type powerplants, depending upon performance characteristics desired. The higher power/weight ratio of aircraft powerplants probably would provide better payload characteristics and speeds, but automotive powerplants would permit greater economy in operation. Basically, Curtiss-Wright anticipates that Air-Car designs will weigh approximately 425 lb. per passenger or payload equivalent.

According to engineers, the vehicles can be circular, oval, square or oblong, depending upon requirements. They say that a vehicle having the approximate ground area of a Volkswagen would be capable of supporting a 200-lb. payload with a 65-hp. powerplant; an Air-Car comparable to that of a limousine would weigh 1,500 lb. and carry 700 lb. using 300 hp.

Lockheed Refines JetStar Design

Numerous refinements are being developed for the Lockheed JetStar four-jet executive transport and Air Force utility plane to reduce landing and takeoff distances, increase gross weight, provide better ground handling characteristics and improved crew visibility.

Thrust reversers, fitted to the airplane's Pratt & Whitney JT12 turbojets, are expected to reduce landing roll by several hundred feet compared with current performance. With jet reversers the JetStar will come to a complete stop in less than 2,000 ft., Lockheed reports. Reversers are a clamshell configuration.

High-lift leading edges added to wings are also expected to reduce takeoff and landing field lengths. When leading edge is lowered, stall speeds will be reduced to 86 kt.

Production models of the JetStar, powered by four JT12s, will have a gross landing weight of 28,000 lb., an increase of 2,000 lb. over the twin-engine prototypes now flying. Range will be 2,850 statute miles with 45-min. reserve. Lockheed predicts that installation of JT12s will permit operators to fly the JetStar for approximately 300,000 mi. initially without engine overhaul—they expect this to increase to between a half million and one million miles soon.

Landing gear will be changed to incorporate dual main and nose wheels to provide improved ground handling, safety and lower tire pressures.

Overhead clear vision panels will be provided in the cockpit area to give better visibility to pilot and copilot and new landing lights will yield 2¼ times the illumination of those on the prototypes.

Potez Plans to Build Light Aircraft Engine

Paris—French aircraft manufacturer Henry Potez will go out for a piece of the small-engine market with a 90-hp. engine interchangeable with the Continental C90.

Potez has built eight prototypes of the new engine and has orders for some 300 more. Price, not yet set, will depend on quantities produced; goal is 1,000 a year. Engine is being considered for military vehicles as well as light aircraft applications.

Although certain exterior details of the Potez engine match the Continental: mounting points, carburetor air in-

U. S. Business & Utility Aircraft Shipments

April 1959

Manufacturer and Model	No. of Units	Net Billings
Aero Design 500	5	$853,000
560E	5	
680E	3	
Beech E18S	9	$3,565,000
Bonanza	40	
Mentor[1]	13	
Twin-Bonanza	8	
Travel Air	13	
Call Air Model A5	2	$32,000
Model A8	2	
Cessna L-19[1]	12	$4,451,000
180	72	
172	66	
175	59	
180	22	
182	86	
310C	27	
Champion Model 7EC	3	$129,000
Model 7FC	7	
Model 7GC	13	
Colonial C-2 Skimmer IV	3	$72,000
Fairchild F-27	2	$1,400,000[2]
Helio H.391B Courier	N.A.	N.A.
H.395 Super Courier	N.A.	N.A.
Mooney Mk.20	16	$184,000
Piper PA-18	18	$3,886,175
PA-18-A Super Cub	41	
PA-22 Tri-Pacer	66	
PA-23 Apache	47	
PA-24 Comanche 180	33	
PA-24 Comanche 250	72	
Totals	703	$14,552,175

[1] Military trainer and liaison aircraft handled as commercial sales, for export.
[2] F-27 totals represent direct factory sales at retail.
January-April total business and utility aircraft shipments represent approximately 2,882 aircraft valued at $50.9 million. This compares with 2,318 aircraft, valued at approximately $37.8 million shipped in the same period last year.
N.A.—Not available.

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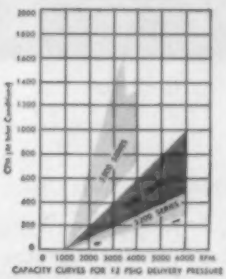

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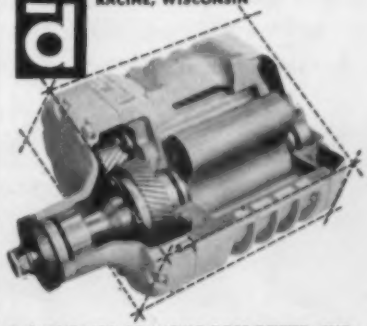

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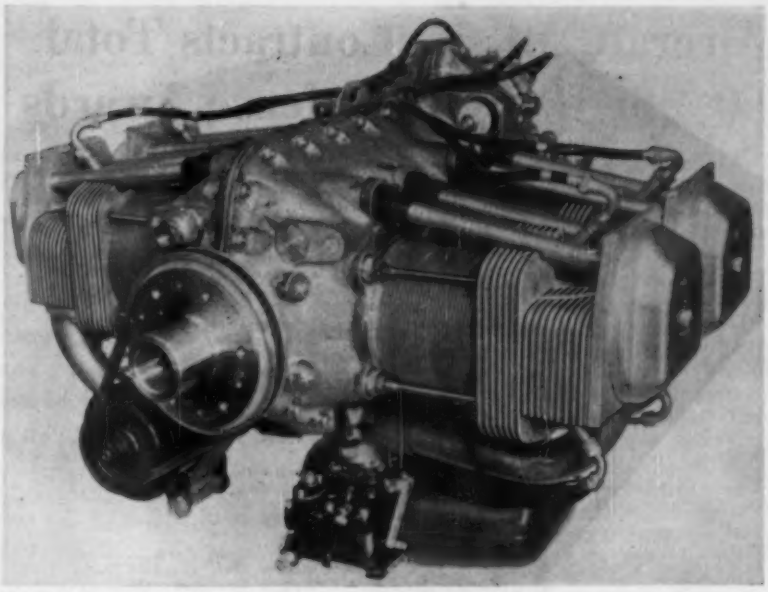

FRONT VIEW of the 90 hp. Potez engine for light aircraft.

take and exhaust location-basic design is different. Engine develops 2,475 rpm. at rated power.

Heart of the four cylinder, opposed, horizontal engine is a two-piece light alloy crankcase. Steel cylinders with light-alloy heads attach to the crankcase by steel tie rods. Camshaft and valve actuating mechanisms are at the top; intake and exhaust manifolds at the bottom.

Carburetor is a Zenith 42M200, with automatic altitude correction.

Another feature of the design, and a cost-cutting one, is a considerable use of automotive techniques. Ignition is automotive type, but with two spark plugs per cylinder and two independent circuits. Both the generator and the starter motor are production automotive types. Crankshaft main and connecting rod bearings are thin-wall automotive types with copper-lead-indium linings.

Basic specifications of the motor include takeoff rating of 96 hp. at 2,530 rpm.; maximum cruising power 68 hp. at 2,300 rpm.; fuel consumption at maximum cruising power ½ lb./hp./hr; bore 110 mm., stroke 90 mm.; compression ratio 7 to 1; weight 207 lb.

Piper Approves Seven Vacation Flight Areas

Piper Aircraft Corp.'s "Learn on Vacation" flight training program is being expanded on a nationwide scale this summer as a result of its successful field tryout last season at Edgartown, Mass. (AW June 23,1958, p. 79).

Program is designed to make it possible for executives, potential private pilots and their families, who have difficulty maintaining regular flight training schedules during the year because of business, to take accelerated courses—designed to provide solo capability in a week—at selected areas where they can also enjoy vacations.

The seven locations, designated by the business plane manufacturer as Approved Vacation Flight Centers, after screening of the airport facilities and surrounding areas, include: Prescott Air Service, Prescott, Ariz.; Red Aircraft Service, Inc., Broward County International Airport, Ft. Lauderdale, Fla.; Martha's Vineyard Air Service, Inc., Katama Airpark, Edgartown, Mass.; Jamestown Aviation Co., Municipal Airport, Jamestown, N. Y.; Western Hills Lodge, Sequoyah State Park, Wagoner, Okla.; Tufts-Edgcumbe, Inc., Boulder Junction Airport, Boulder Junction, Wis.; and Jackson Hole Scenic Flights, Jackson, Wyo.

Autopilot-Omni Coupler Offered in New Version

Latest version of Dynavia autopilot-omni coupler, Model ANC-3, provides continuous control signals to rudder and aileron axes of Lear L-2 autopilot from Aircraft Radio Corp. CD-1 course director, compared with earlier versions which gave rudder control only. Unit enables aircraft to automatically intercept and track any selected inbound or outbound VOR radial or localizer beam, compensating for crosswinds. In the heading modes, automatic turns can be made to any selected magnetic heading to aid in following radar vectors or bracketing a low-frequency beam.

Units are built by Flight Research, Inc., P. O. Box 1-F, Richmond, Va.

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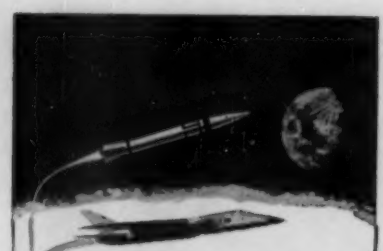

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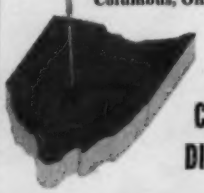

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Aircraft, Missile Contracts Total 60% of 100 Top Defense Awards

Washington—Aircraft and missile contracts accounted for about 60% of the value of military prime contracts of more than $500,000 awarded to the 100 top defense contractors in Calendar Year 1958, Department of Defense has reported.

Defense said that 62 of the top 100 companies are engaged in aircraft and missile work, with another 10% going to companies involved in avionics production and development.

Boeing Airplane Co. led the CY 1958 list for the second consecutive year, with 8% of the 74% which is the top 100 companies' share of the total defense contracts (AW June 22, p. 92).

Boeing is followed by General Dynamics Corp., General Electric Co., Lockheed Aircraft Corp., and North American Aviation, which replaced United Aircraft Corp. for 5th place. United Aircraft dropped to 14th on the CY 1958 list.

Chrysler Corp., which received substantial contracts for production of Jupiter intermediate range ballistic missile, moved from 20th place to 12th, and Chance Vought Aircraft, which suffered from project cancellations and stretchouts, such as the Regulus missile, slumped drastically from 12th to 65th place. Grumman Aircraft Engineering Corp. also dropped, from 21st to 47th place.

Nearly half of the prime contract funds awarded to the top 100 firms were subcontracted out to other companies.

Following is a breakdown of the 100 top companies, their divisions or subsidiaries, and the total contract funding involved:

RANK	COMPANIES	MILLIONS OF DOLLARS
	U. S. TOTAL[a]	$23,817.1
	TOTAL, 100 COMPANIES AND THEIR AFFILIATES[b]	17,633.4
1.	**Boeing Airplane Co.**	1,894.5
2.	**General Dynamics Corp.**	1,542.2
	Electronic Control Systems, Inc.	0.1
	Total	1,542.3
3.	**General Electric Co.**	952.3
	International General Electric Co., Inc. (Puerto Rico)	0.1
	Total	952.4
4.	**Lockheed Aircraft Corp.**	867.3
	Lockheed Aircraft Service, Inc.	30.3
	Lockheed Aircraft Service International, Inc.	11.6
	Lockheed Aircraft Service Overseas, Inc.	20.9
	Lockheed Air Terminal, Inc.	1.3
	Total	931.4
5.	**North American Aviation, Inc.**	900.7
	Astrodyne, Inc.[c]	2.0
	Total	902.7
6.	**American Telephone & Telegraph Co.**	0.5
	Teletype Corp.	2.9
	Western Electric Co.	788.6
	Total	792.0
7.	**Douglas Aircraft Co.**	673.4
8.	**Hughes Aircraft Co.**	565.7
9.	**Martin Co.**	459.2
	Rias, Inc.	0.2
	Total	459.4
10.	**Sperry Rand Corp.**	410.0
	Vickers, Inc.	13.6
	Wright Machinery Co.	0.1
	Total	423.7
11.	**International Business Machines Corp.**	417.4
	Service Bureau Corp.	0.2
	Total	417.6
12.	**Chrysler Corp.**	411.5
	Chrysler Airtemp Sales Corp.	5.7
	Total	417.2
13.	**McDonnell Aircraft Corp.**	411.5
14.	**United Aircraft Corp.**	400.5
	United Aircraft Service Corp.	[d]
	Total	400.5
15.	**Radio Corp. of America**	355.9
	National Broadcasting Co.	0.1
	RCA Victor Distributing Corp.	0.1
	Total	356.1
16.	**Republic Aviation Corp.**	351.0
17.	**General Motors Corp.**	282.5
	Ethyl Corp.[c]	0.1
	Frigidaire Sales Corp.	0.1
	Total	282.7
18.	**Raytheon Mfg. Co.**	274.1
19.	**Westinghouse Electric Corp.**	271.1
	Westinghouse Electric International, Inc.	0.1
	Westinghouse Electric Supply Co.	0.4
	Westinghouse Appliance Sales Corp.	[d]
	Total	271.6
20.	**Northrop Corp.**	245.1
21.	**Bendix Aviation Corp.**	243.5
	Bendix-Westinghouse Automotive Air Brake Co.	0.1
	Sheffield Corp.	0.1
	Total	243.7
22.	**Standard Oil Co. (N.J.)**	0.0
	Carter Oil Co.	9.9
	Enjay Co., Inc.	[d]
	Esso Export Corp.	136.8
	Esso Research & Engineering Co.	0.7
	Esso Standard Oil Co.	37.8
	Ethyl Corp.[c]	0.1

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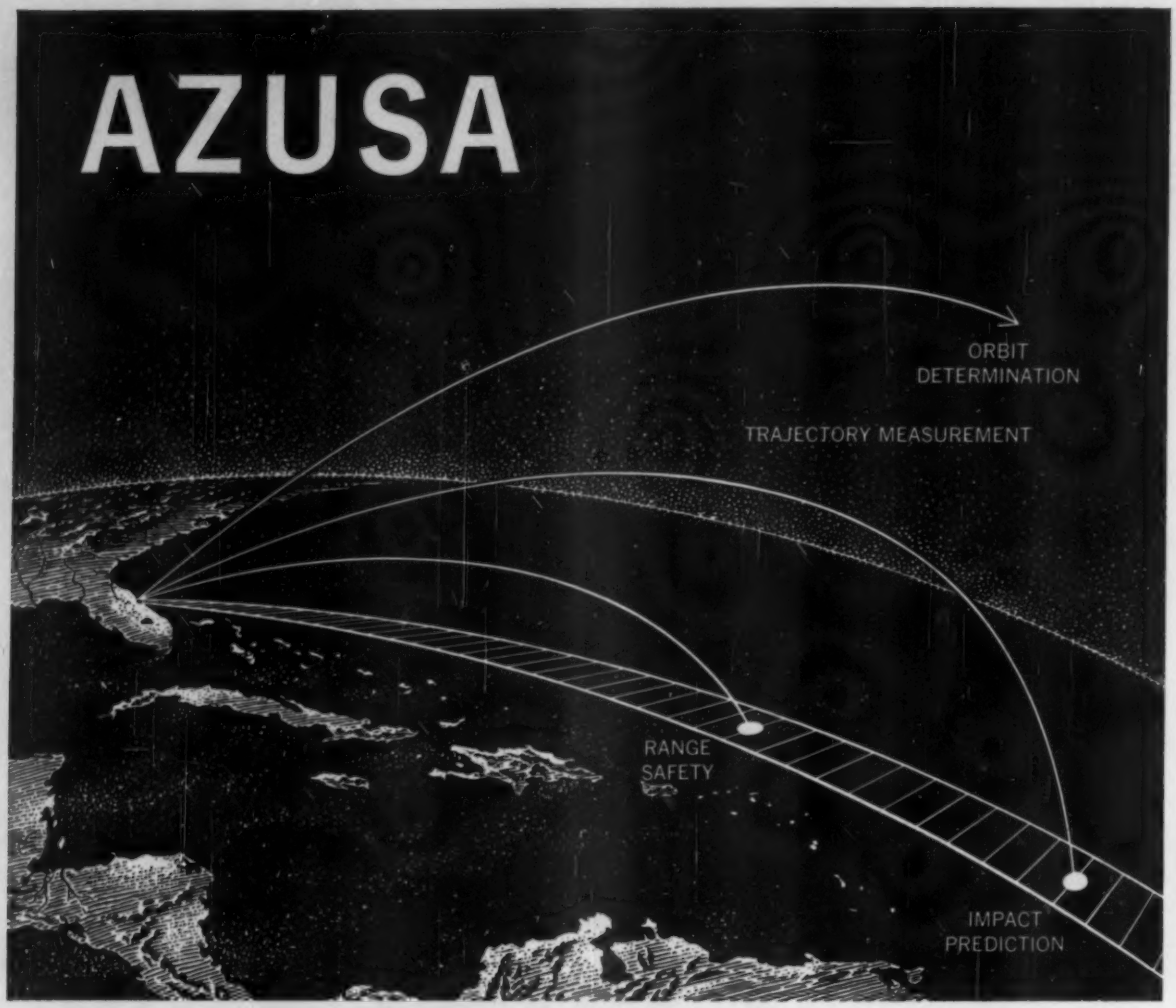

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If you feel qualified in one of these specialties, please write at once, giving full details of your background and education, to Mr. G. N. McMillan, Engineering Personnel Administrator, Department 130-90

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RANK	COMPANIES	MILLIONS OF DOLLARS
	Gilbert & Barker Mfg. Co...	$0.1
	Humble Oil & Refining Co...	5.2
	Penola Oil Co....	1.6
	Standard Vacuum Oil Co.[f]..	2.4
	Total	194.6
23.	**General Tire & Rubber Co...**	15.0
	Aerojet-General Corp.....	162.4
	Byers (A. M.) Co.....	1.3
	RKO Teleradio Pictures, Inc.	0.1
	Total	178.8
24.	**Curtiss-Wright Corp. .....**	150.7
	Propulsion Research Corp....	0.3
	Total	151.0
25.	**International Telephone & Telegraph Co. .....**	58.4
	Federal Electric Corp.....	75.8
	Intelex Systems, Inc.....	0.2
	Kuthe Laboratories, Inc.....	1.3
	Mackay Radio & Telegraph Co.	[d]
	Royal Electric Corp.....	0.1
	Total	135.8
26.	**Standard Oil Co. of California .....**	76.1
	American Bitumuls & Asphalt Co.	0.1
	California Oil Co.....	3.8
	California Research Corp....	0.1
	California Spray Chemical Co.	[d]
	California Tanker Co.....	0.2
	Caltex Oil Products Co.[g]....	41.1
	Lincoln Oil Co.....	[d]
	Overseas Tankship Corp.[g]...	0.2
	Pacific Oil Co.....	[d]
	Standard Oil Co. of Texas...	10.6
	Total	132.2
27.	**Bath Iron Works Corp.....**	117.2
28.	**Fairchild Engine & Airplane Corp. .....**	112.4
29.	**Burroughs Corp. .....**	105.3
	Control Instrument Co.....	1.7
	Total	107.0
30.	**Goodyear Tire & Rubber Co..**	29.8
	Goodyear Aircraft Corp.....	71.1
	Goodyear Engineering Corp..	1.7
	Kelly Springfield Tire Co....	[d]
	Total	102.6
31.	**Avco Mfg. Corp.....**	102.0
32.	**Brown-Raymond-Walsh[h] ....**	100.3
33.	**Texas Co. .....**	54.2
	Caltex Oil Products Co.[g]....	41.1
	Overseas Tankship Corp.[g]...	0.2
	Texas Co. (Caribbean), Ltd.	[d]
	Texas Co. (Puerto Rico), Inc.	0.1
	Texas Petroleum Co.....	4.1
	Total	99.7
34.	**Minneapolis-Honeywell Regulator Co. .....**	86.0
	Marion Electrical Instrument Co.	0.1
	Total	86.1
35.	**American Bosch Arma Corp..**	85.4
36.	**Collins Radio Co.....**	84.4
37.	**Bell Aircraft Corp.....**	54.4
	Bell Helicopter Corp.....	27.3
	Hydraulic Research Mfg. Co.	0.2
	Wheelabrator Corp.	0.1
	Total	82.0
38.	**Pan-American World Airways, Inc. .....**	81.8
39.	**Thiokol Chemical Corp..... **	$81.7
	Hunter-Bristol Corp.	[d]
	Total	81.7
40.	**Socony Mobil Oil Co.....**	15.8
	Basin Oil Co.....	[d]
	General Petroleum Corp.....	16.6
	Magnolia Petroleum Co.....	7.0
	Mobil Overseas Oil Co., Inc..	36.8
	Standard Vacuum Oil Co.[f]...	2.4
	Total	78.6
41.	**Shell Caribbean Petroleum Co. .....**	49.7
	International Lubricant Corp.	0.6
	Shell Chemical Corp.....	1.2
	Shell Development Co.....	0.5
	Shell Oil Co.....	26.5
	Total	78.5
42.	**Continental Motors Corp....**	34.6
	Continental Aviation & Engineering Corp.	42.3
	Gray Marine Motor Co.....	0.1
	Wisconsin Motor Corp.....	[d]
	Total	77.0
43.	**Ford Motor Co.....**	64.2
	Aeronutronics Systems, Inc..	12.2
	Total	76.4
44.	**Thompson Ramo Wooldridge, Inc. .....**	71.9
45.	**Kiewit (Peter) Sons Co.....**	71.9
46.	**Philco Corp. .....**	71.0
	Lansdale Tube Co.....	0.2
	Sierra Electronics Co.....	0.3
	Total	71.5
47.	**Grumman Aircraft Engineering Corp. .....**	68.7
	Dynamic Developments, Inc..	[d]
	Total	68.7
48.	**Cities Service Co.....**	0.0
	Arkansas Fuel Oil Corp.....	1.3
	Cities Service Gas Co.....	0.3
	Cities Service Oil Co.....	64.9
	Orange State Oil Co.....	0.5
	Total	67.0
49.	**Hayes Aircraft Corp.....**	64.4
50.	**Olin Mathieson Chemical Corp. .....**	62.1
	Liberty Powder Co.....	1.2
	Liberty Powder Defense Corp.	0.5
	Total	63.8
51.	**Greenland Contractors[i] .....**	63.2
52.	**Massachusetts Institute of Technology .....**	60.1
53.	**Bethlehem Steel Corp.....**	0.0
	Bethlehem Pacific Coast Steel Corp.	8.1
	Bethlehem Sparrows Point Shipyard, Inc.	0.1
	Bethlehem Steel Co.....	51.5
	Bethlehem Steel Export Co..	0.1
	Total	59.8
54.	**Union Oil Co. of California.**	58.9
55.	**Todd Shipyards Corp.....**	55.8
56.	**Tidewater Oil Co.....**	52.8
	Seaside Oil Co.....	[d]
	Total	53.8
57.	**Garrett Corp. .....**	51.5
58.	**California Institute of Technology .....**	50.4
59.	**Rand Corp. .....**	15.1

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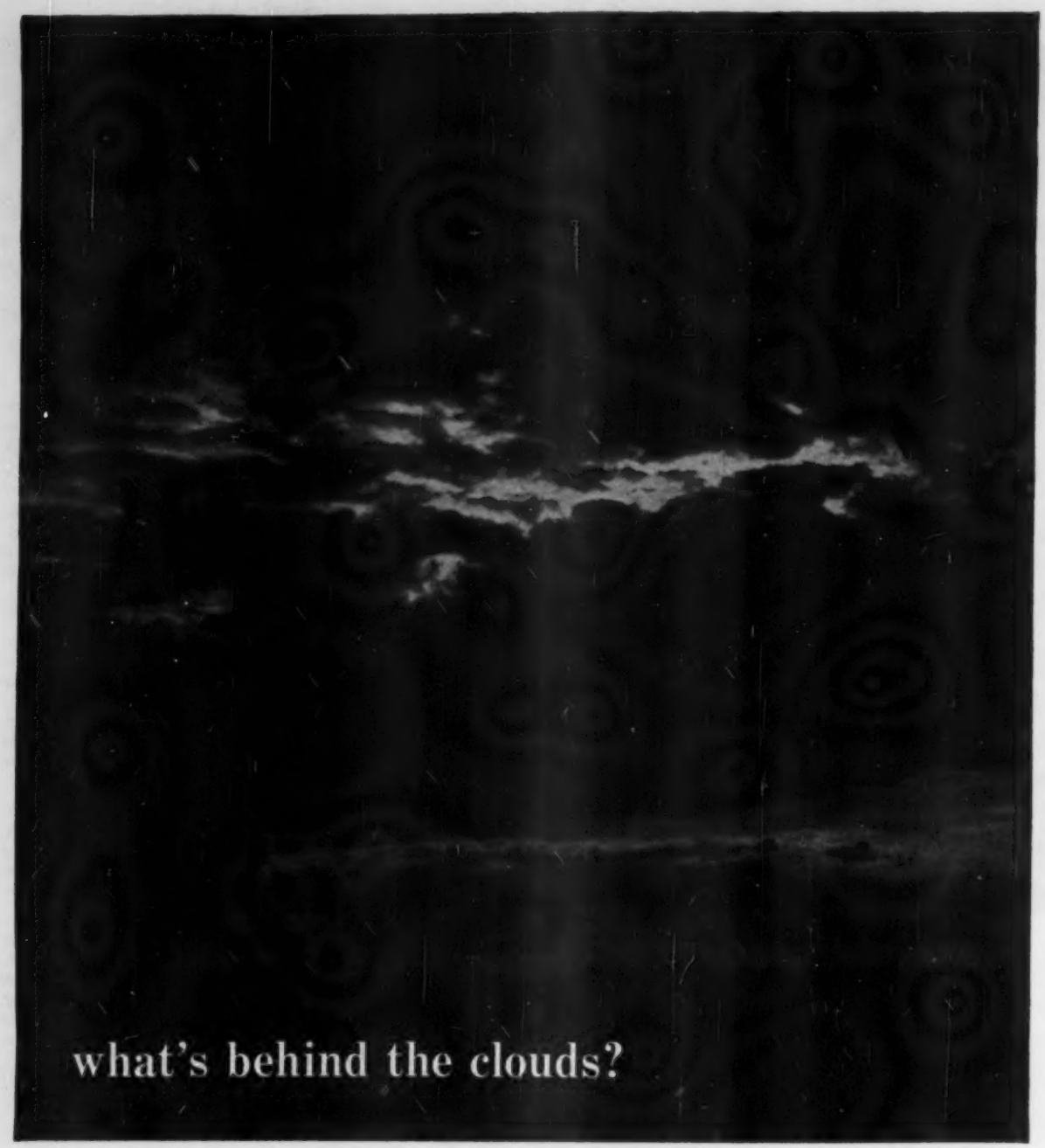

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RANK	COMPANIES	MILLIONS OF DOLLARS
	Systems Development, Inc...	35.0
	Total	50.1
60.	**Merritt-Chapman & Scott Corp.**	2.2
	Devoe & Raynolds Co., Inc...	0.4
	New York Shipbuilding Corp.	47.3
	Tennessee Products & Chemical Co.	0.1
	Total	50.0
61.	**White Motor Co.**.....	9.3
	Diamond T. Motor Truck Co.	40.4
	Total	49.7
62.	**Ryan Aeronautical Co.**.....	49.1
63.	**Firestone Tire & Rubber Co.**	47.9
	Firestone Industrial Products Co.	0.1
	Total	48.0
64.	**Food Machinery & Chemical Corp.**	47.8
65.	**Chance Vought Aircraft, Inc.**	46.4
66.	**Lear, Inc.**	44.3
67.	**General Precision Equipment Corp.**	0.2
	GPE Controls, Inc.....	0.1
	General Precision Laboratory, Inc.	7.8
	Graflex, Inc.	1.0
	Griscom-Russell Co.	0.1
	Hertner Electric Co.....	d
	Kearfott Co., Inc.....	13.9
	Librascope, Inc.	3.3
	Link Aviation, Inc.....	17.9
	National Theater Supply Co..	d
	Strong Electric Corp.....	(=)0.1
	Total	44.2
68.	**Northern Pump Co.**.....	0.0
	Northern Ordnance, Inc.....	43.4
	Total	43.4
69.	**Sylvania Electric Products, Inc.**	$41.2
70.	**Penn-Texas Corp.**	0.0
	Colt's Mfg. Co.....	0.1
	Fairbanks, Morse & Co.....	7.0
	Pratt & Whitney Co.....	18.5
	Quickway Truck Shovel Co..	15.0
	Total	40.6
71.	**Marquardt Aircraft Co.**.....	39.1
	Cooper Development Corp....	0.7
	Total	39.8
72.	**Temco Aircraft Corp.**.....	38.2
	Fenske Fedrick & Miller Inc.	0.1
	Total	38.3
73.	**Westinghouse Air Brake Co..**	10.1
	Le Tourneau - Westinghouse Co.	3.2
	Melpar, Inc.	24.6
	Union Switch & Signal Construction Co.	d
	Total	37.9
74.	**Hercules Powder Co.**.....	37.1
	Young Development Laboratories, Inc.	0.1
	Total	37.2
75	**Asiatic Petroleum Corp.**.....	37.2

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RANK	COMPANIES	MILLIONS OF DOLLARS
76.	**Continental Oil Co.**	36.6
77.	**Sundstrand Machine Tool Co.**	36.1
	Sundstrand Aircraft Service Corp.	0.2
	Total	36.3
78.	**Cessna Aircraft Co.**	35.8
79.	**States Marine Corp.**	23.5
	States Marine Corp. (Del.)	5.7
	Isthmian Lines	6.0
	Total	35.2
80.	**Goodrich, (B. F.) Co.**	34.5
81.	**Phillips Petroleum Co.**	$32.3
	Astrodyne, Inc.[c]	2.0
	Total	34.3
82.	**Johns Hopkins University**	34.2
83.	**Texas Butadiene & Chemical Corp.** [e]	33.8
84.	**Motorola, Inc.**	33.1
	Motorola Communications & Electronics, Inc.	0.1
	Total	33.2
85.	**Defoe Shipbuilding Co.**	33.1
86.	**Flying Tiger Line, Inc.**	32.8
87.	**Oman-Farnsworth-Wright-Kaiser-Morrison-Knudsen**[j]	32.7
88.	**Blue Cross Assn., Inc.**	32.7
89.	**Standard Oil Co. (Indiana)**	13.5
	American Oil Co.	12.6
	Tuloma Gas Products Co.	[d]
	Utah Oil Refining Co.	6.6
	Total	32.7
90.	**Kaman Aircraft Co.**	32.0
91.	**Eastman Kodak Co.**	30.0
	Eastman Chemical Products, Inc.	[d]
	Eastman Kodak Stores, Inc.	0.4
	Recordak Corp.	1.3
	Total	31.7
92.	**Transocean Corp. of California**	0.0
	Aircraft Engineering & Maintenance Co.	6.2
	Flight Enterprises, Inc.	12.8
	Oakland Aircraft Engine Services, Inc.	3.0
	Transocean Air Lines, Inc.	8.9
	Total	30.9
93.	**Richfield Oil Corp.**	$30.2
	American Mineral Spirits Co.	0.3
	Total	30.5
94.	**Hoffman Electronics Corp.**	30.1
95.	**Du Pont (E. I.) de Nemours & Co.**	2.9
	Mall Tool Co.	26.3
	Remington Arms Co.	0.1
	Total	29.3
96.	**Oman-Farnsworth-Wright**[j]	28.3
97.	**Laboratory For Electronics, Inc.**	27.9
98.	**Sunray Midcontinent Oil Co.**	0.3
	DX Sunray Oil Co.	25.2
	Suntide Refining Co.	2.4
	Total	27.9
99.	**California Eastern Aviation, Inc.**	4.9
	Land-Air, Inc.	22.6
	Total	27.5
100.	**American Machine & Foundry Co.**	27.2
	AMF Pinspotters, Inc.	0.1
	Beaird (J. B.), Inc.	[d]
	Potter & Brumfield, Inc.	0.1
	Total	27.4

FOOTNOTES:

[a] Net value of new procurement actions minus cancellations, terminations and other credit transactions. The data include debit and credit procurement actions of $10,000 or more, under military supply, service and construction contracts for work in the U. S., plus awards to listed companies and other identifiable U. S. companies for work overseas.

Procurement actions include definitive contracts, the obligated portions of letters of intent and letter contracts, purchase orders, job orders, task orders, delivery orders, and any other orders against existing contracts, and debit and credit actions that amend, cancel or terminate contracts. The data do not include that part of open-end or indefinite quantity contracts that have not been translated into specific orders on business firms. The data do not include purchase commitments or pending cancellations that have not yet become mutually binding agreements between the government and the company.

[b] The assignment of subsidiaries to parent companies is based on stock ownership of 50% or more by the parent company, as indicated by data published in standard industrial reference sources. The company totals do not include contracts made by other U. S. government agencies and financed with Defense Department funds, or contracts awarded in foreign nations through their respective governments. The company names and corporate structures are those in effect as of Dec. 31, 1958. Only those subsidiaries are shown for which procurement actions have been reported.

[c] Stock ownership is equally divided between North American Aviation, Inc. & Phillips Petroleum Co.; one-half of the total military awards is shown under each of the parent companies.

[d] Less than $50,000.

[e] Stock ownership is equally divided between General Motors Corp. and Standard Oil Co. of New Jersey; half of the total military awards is shown under each of the parent companies.

[f] Stock ownership is equally divided between Standard Oil Co. of New Jersey and Socony Mobil Oil Co.; half of the total of military awards is shown under each of the parent companies.

[g] Stock ownership is equally divided between Standard Oil Co. of California and Texas Co.; half of the total of military awards is shown under each of the parent companies.

[h] A joint venture of Brown & Root, Inc., Raymond International, Inc., and Walsh Construction Co.

[i] A joint venture of Kiewit (Peter) Sons, Inc., Groves (S. J.), Sons Co., Johnson (Al) Construction Co., and Condon Cunningham, Inc.

[j] A joint venture of Oman Construction Co., Farnsworth (R. P.) Co. and Wright Contracting Co. (itself a joint venture), Kaiser (Henry J.) Construction Co., and Morrison-Knudsen Co., Inc.

Solar Flare Study To Use Nike Asps

Washington—Naval Research Laboratory last week received a $250,000 grant from National Science Foundation to make rocket observations of ultraviolet and X-ray emissions from solar flares.

Observations will be made during a series of launches of highly instrumented Nike Asp rockets, according to Dr. Herbert Friedman, NRL's superintendent of the Atmosphere and Astrophysics Division.

Previous NRL rocket experiments involved photographs of the entire sun, using ultraviolet radiation originating in the outer portions of the solar atmosphere (AW April 6, p. 32). Use of rocket astronomy may result in daily solar weather reports which could be used to predict their reactions on the earth's weather and radio communications, according to NRL.

Instrumentation for Nike Asp vehicles will include X-ray detectors for wavelengths of 8-20 and 44-60 Angstroms; Geiger counters to measure X-rays in the 1-10 Angstrom range; scintillation counters sensitive to hard X-rays in the 20-500 kv. range, and ion chambers sensitive to helium emission lines at 584, 314 Angstroms.

Aeronutronic Made Division of Ford

Aeronutronic Systems, Inc., is now Aeronutronic, a division of Ford Motor Co.

More than 90% of Aeronutronic's outstanding common stock is now owned by Ford with minority interest being held by certain key Aeronutronic personnel. In the merger, the employe stockholders will acquire shares of Ford common at a ratio of one share of Ford stock for approximately 2.4 shares of Aeronutronic stock.

Gerald J. Lynch, Aeronutronic president, will become general manager of the new division. Effective with the merger, Aeronutronic operating groups will be known as computer operations, headed by Dr. Ernst H. Krause, tactical weapons systems operations, headed by Roy P. Jackson, range systems operations, also headed by Dr. Krause, and space technology operations, and office of advanced research, both headed by Dr. Montgomery H. Johnson.

Aeronutronic is now constructing a $22 million engineering and research center on a 200-acre site at New Port Beach, Calif. Already completed and in operation there are facilities for an advanced aerothermo chemical laboratory. Full occupancy by the computer electronics facility is expected early in July.

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PUBLICATION DATE
APRIL 1, 1959

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Field elevation
Latitude and Longitude
Name of aeronautical chart
Runway surface, direction, length and condition
Right or left traffic pattern
Airport of entry
Rotating beacon, code beacon or both
Field lighting
Field markers
Type and direction of obstruction
Hours service available
Number and size of hangars
Administration Building
Control Tower
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WHO'S WHERE

(Continued from page 23)

Changes

H. M. Wittner, manager of the newly formed Advanced Systems Engineering Operation of General Electric's Missile and Space Vehicle Department, Philadelphia, Pa. Appointed submanagers of the new Operation are: **Robert L. Francisco**—advanced test, search, and recovery; **C. Frank Hix, Jr.**—advanced missile engineering; **Richard A. Passman**—advanced re-entry vehicle engineering; **Robert R. Reid**—advanced satellite and probe engineering; **Stanley C. Tracz**—global surveillance study operation; **L. W. Warzecha**—advanced space vehicle engineering.

James R. Black, manager, Microelectronics Laboratory, Solid State Electronics Department, Motorola's Military Electronics Division, Phoenix, Ariz.

Dr. Robert E. Payne, head of Space Technology Laboratories' Atlas Project Office, Cape Canaveral, Fla. Also: **H. J. Doane,** associate head of STL's Thor Project Office, Flight Test Operations, Cape Canaveral.

Dr. J. Earl Thomas, Jr., director of research and engineering, Semiconductor Division, Sylvania Electric Products, Inc., Woburn, Mass. Also: **Irving Shapiro,** manager of quality control for the division.

Oscar H. Bauschinger, Jupiter project manager, Ford Instrument Co., Division of Sperry Rand Corp., Long Island City, N. Y.

Dr. Kenneth Brasted, administrative director, Central Research Laboratory, Texas Instruments, Inc., Dallas, Tex. Also: **Richard C. Wood,** marketing manager-advanced technologies, Central Research Laboratory.

Wendell W. Suydam, manager, Overhaul and Repair Department, Hamilton Standard Division, Windsor Locks, Conn.

George Makowski, assistant to the chief engineer, the Garrett Corp.'s AiResearch Manufacturing Division, Los Angeles, Calif.

King D. Bird, head, and **James F. Martin,** assistant head, of the newly created Hypersonic Tunnel Department, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y. **John P. Andes** succeeds Mr. Bird as head of the Transonic Tunnel Department; **Ray W. Cotter** succeeds Mr. Andes as assistant department head of Transonic Tunnel.

C. S. Wagner, executive assistant to the executive vice president, Lockheed Aircraft Corp., Burbank, Calif. **A. M. Folden** succeeds Mr. Wagner as manufacturing manager, Lockheed's California Division.

Dr. Siegfried Lindena, director of advanced research, Special Products Division, Networks Electronic Corp., Van Nuys.

Sol W. Voorhees, assistant to the president, Pre-Flite Industries, Paramount, Calif., subsidiary of Avco Corp. Also: **James J. Ward,** East Coast representative; **Col. Deane C. Roberts** (USMC, ret.), field representative.

Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., New York, N. Y., has appointed the following general managers for divisional operations: **Richard M. Osgood,** Waltham, Mass., Laboratories; **H. C. Tittle,** Buffalo, N. Y., Operations; **E. J. Vigneron,** Data Systems Operations, Needham, Mass.

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- Aerothermodynamics
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- Space physics
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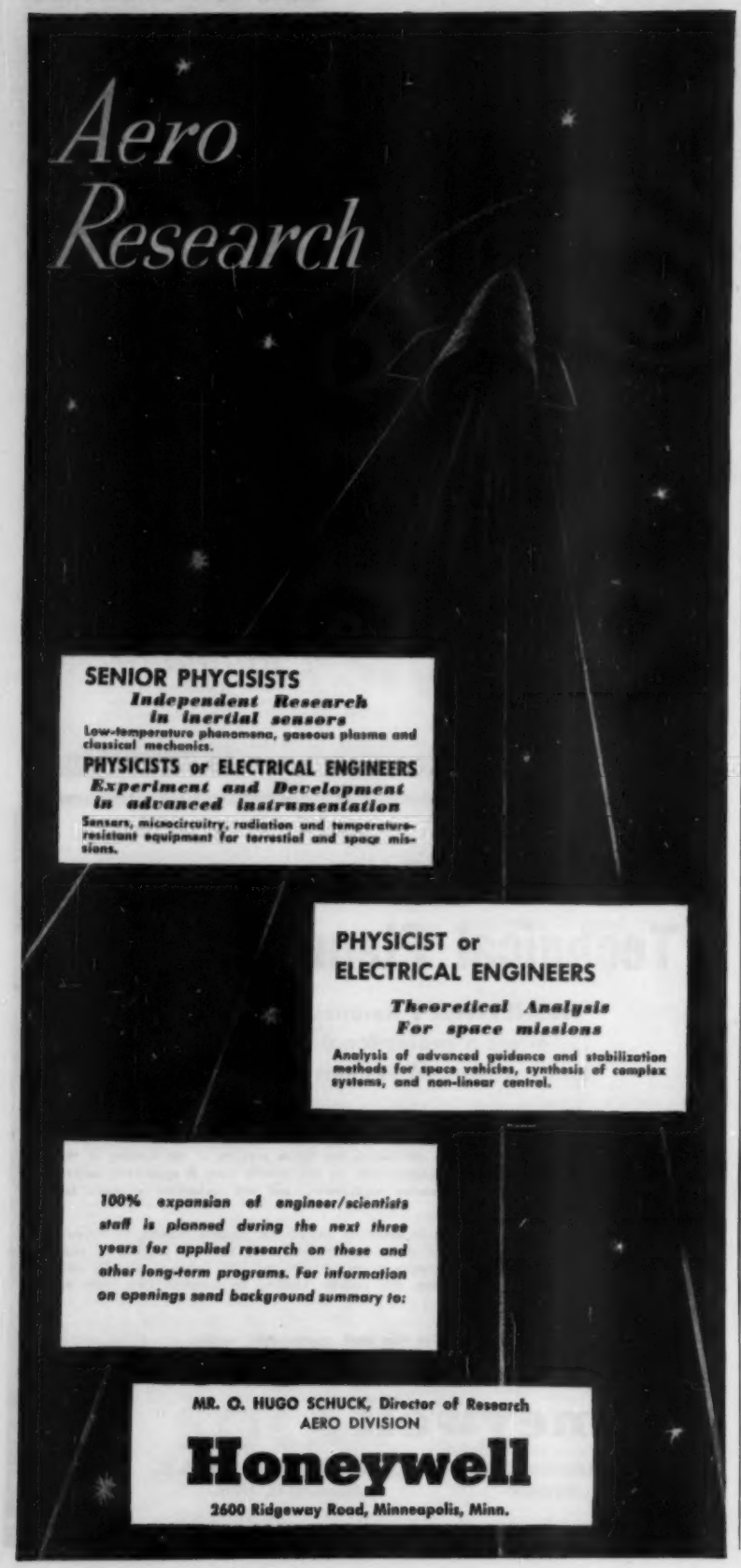
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LETTERS

Betwixt and Between

AVIATION WEEK is now between the devil and the deep blue sea.

You have lost the subscription of Copilot Kennoth L. Dean because you are critical of pilots and airlines. On the other hand, if you adopt a Pollyanna attitude that these groups can do no wrong you will lose my subscription.

ROBERT T. SYMONDS
Former Copilot
United
Transocean

Seeking Truth

If all the "facts" in the letter "Copilot Cancels" (AW June 15, p. 118) are a true indication of how "airline people" operate, then another editorial on the subject is due from some poor confused editor if one is around.

The letter cites a remarkable case of airline crew teamwork and coordination. Apparently the Captain in command considered it his job to test the "stupidity" of the flight engineer by kidding about whether an en route stop would or would not be made. Who proved what, in this episode, is difficult to figure.

Next, the letter insinuates that "airline people" falsified an aircraft log book by removing operational information that would have become pertinent to an air carrier fatal accident.

Now the CAB report of the accident (AW Feb. 9, p. 103) made no mention of these goings on. A reader can conclude that either the CAB knew of this and did not mention it, or else the CAB investigation of the accident was not comprehensive enough to get to the facts.

This would put AVIATION WEEK to a disadvantage to even mention it because some other subscriber might cancel for "secondary reasons . . . unjust criticism of the CAA, FAA, and CAB. . . ." Pardon me if I do not cancel.

However, I believe that CAB should justify itself at this point by investigating and explaining publicly the pertinent information suggested by canceling copilot. If CAB can't do this alone it should enlist the services of some concerned D. A.

The letter further challenges AVIATION WEEK to get at the truth. Engine failures on the copilot's airline are explained as a natural thing following idleness of machinery due to a strike, instead of pilot and engineer confusion in the cockpit as inferred by a recent article in AVIATION WEEK.

AVIATION WEEK would do the public a service by comparing the number of engine failures following strikes of other airlines. There were enough of them (strikes) that some important statistical data should be available on this point. If AVIATION WEEK is afraid or cannot get to this information, then CAB should look into it and render an intelligent report so that airline customers will know just how long to wait, following a strike, before entrusting themselves to the machinery breaking down.

Last, canceling copilot seems justifiably worried in his P.S. that you could ". . . use my own statements to try to make them into something I obviously did not mean."

Perhaps copilot should have left the last word to the Captain Blanchard that he quoted. It seemed to me that the Captain, as I remember his letter (AW May 4, p. 214), did make a rather decent plea for the airline people by saying what he meant.

ROBERT E. TRIMBLE
Washington, D. C.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Airline Service

It was with great pleasure, as usual, that I read your June 15 issue, until I hit the last page and read the Letter to the Editor titled "Copilot Cancels" by Mr. Dean.

Some of the letter I imagine is true, others a difference of interpretation, but the paragraphs devoted to the almost slanderous remarks regarding Mr. Dean's passengers made my blood boil. Your suggestion that the V.P.'s ride with the common herd sometime is excellent, so that they can find out what the flying public has to put up with from the arrogant flight crews that hold the lives of so many in their hands.

In my business I am called on to travel many miles via the commercial airlines every year. I always regret that I can't do all my traveling via my 170, but that can't be helped. I have had it happen on a number of occasions that a prop was feathered, that the plane taxied to the end of the runway to sit there for quite some time and then return to the ramp to sit some more, never a word said by any member of the flight crew. Their attitude always seemed to be "you bought a ticket—so now just wait until we are ready to take you where you want to go."

Mr. Dean's reasons for not telling the flying public what is going on are ridiculous. There are a lot of people on the airlines daily that have flying experience, and they would like to know what is going on. The others certainly deserve more information, too, just to make them more comfortable, especially the ones that are on their "solo" flight.

From my experience, Mr. Dean is not the only flight crew member that has this Commodore Vanderbilt "to hell with the public" attitude, and the idea that the V.P.s get out of their ivory towers to see what is happening with that multi-million dollar equipment can only do the airlines good.

The only thing that I can say good for the airlines is that their equipment is well maintained and that they have managed in the last few years to usually get you where you are going on time, but the getting there is no fun anymore as most of the employes of the commercial airlines, from ticket counter clerk to Senior Captain, worry more about what comes after they leave the job or when the next pay raise comes than they do in satisfying their customer who provides them with their bread and butter.

ROBERT VAN WESTERBORG
Suffolk, Va.

Franklin Engine

Aircooled Motors, Inc., and this office are most appreciative of the space given the new Franklin turbo engine on p. 327 of your June 22 issue.

There is, however, one unfortunate error. The original release stated that the new engine "can be installed in existing Franklin-powered Bell and Hiller helicopters without structural alteration . . ." In your use of it, the word "without" has been changed to read "with." The difference is roughly comparable to the difference between black and white.

We're very much afraid that this error will tend to discourage a good many helicopter owners from even considering installation of the new engine. Would it be possible for you to run a correction?

STEPHEN M. WEBB, vice president
Richards & Webb, Inc.
Syracuse, N. Y.

Ion Rockets

I read the articles on ion rocketry in AVIATION WEEK with a great deal of pleasure and interest. The May 11, p. 32, article certainly did a fine job of integrating several of the papers at the ARS meeting into a real picture of what lies ahead. The June 1, p. 33, article gave a good appraisal of the state of the art at GE and NASA, though one might get the impression from the third paragraph that some problems are solved which are merely well under way.

Articles such as these will perform a most useful service in the development of electrical space propulsion. They will set the designers of many satellite vehicles to thinking about the benefits which ion rockets can bring. It is particularly valuable to get across the idea that ion rockets can lie in the near future rather than some nebulous time at the end of the next decade.

Incidentally, the development of small, low-power-level ion rockets can be particularly important for the early test flights. A few kilowatts will still be a lot of power in space in 1961. Forty or 50 kilowatt requirements might delay testing for several years.

RUSSELL N. EDWARDS
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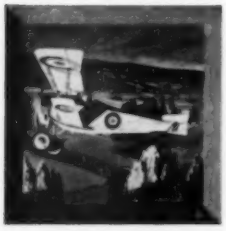
The formation of the *Associates* is prompted by the unusual interest and response accorded to the Heritage of the Air series over the past six months. *By becoming a charter member of this group, you will help to decide future subjects to be included in the series, and will also automatically receive any future mailings planned in connection with this popular historical feature.*



WHICH WORLD WAR I PLANE WOULD YOU LIKE TO SEE NEXT?

Your vote will help determine future subjects of Heritage of the Air.

Fill out the reply card now. You will cast your vote for future subjects and automatically become a member of *Heritage of the Air Associates.* You will be under no obligation of any kind—merely fill out the adjacent reply card and state your preferences.

IMPORTANT NOTE: Mailings have now started on the original offer of free reprints of the Heritage of the Air series. If you have already sent in a request for reprints, they will be in the mail to you within a few days. If you have not requested reprints, do so now by mailing the reply card.

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July 13, 1959